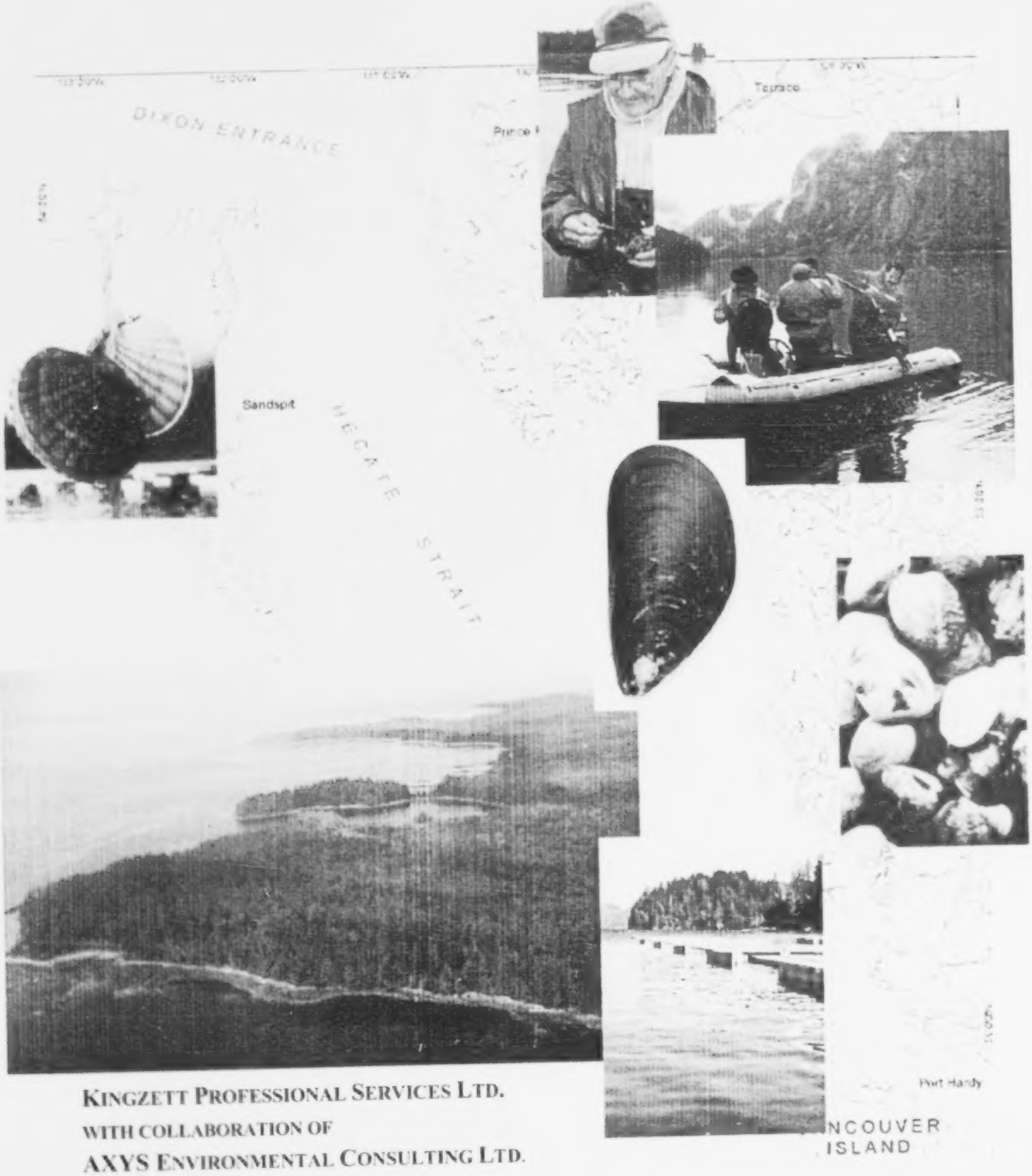
FIRST NATIONS SHELLFISH AQUACULTURE REGIONAL BUSINESS STRATEGY

BC CENTRAL AND NORTH COAST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KINGZETT PROFESSIONAL SERVICES LTD.
WITH COLLABORATION OF
AXYS ENVIRONMENTAL CONSULTING LTD.

FIRST NATIONS SHELLFISH AQUACULTURE REGIONAL BUSINESS STRATEGY

BC CENTRAL AND NORTHERN COAST

NOVEMBER 2002

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FIRST NATIONS SHELLFISH
AQUACULTURE
REGIONAL BUSINESS
STRATEGY

LIST OF SECTIONS

Introduction

Aquaculture From a Global and Provincial Perspective

Production and Culture of Farmed Shellfish Species Overview

Site Selection for Shellfish Aquaculture

First Nation Territory Specific Discussions

Food Safety and Shellfish Aquaculture

Shellfish Aquaculture Marketing Overview

Business Development Overview

Shellfish Aquaculture Governance and Licensing

Shellfish Aquaculture Project Development

Regional Strategy for Shellfish Aquaculture Development

1.0 Introduction

Table of Contents

1.1 Objectives 2
1.2 Background 4
  Potential for First Nations Participation in Shellfish Aquaculture 5
  Developmental Principles Governing Aquaculture Development 6
1.3 Contents of Report 7
  Section 1 – Introduction 7
  Section 2 – Aquaculture From a Global and Provincial Perspective 7
  Section 3 - Production and Culture of Farmed Shellfish Species Overview 7
  Section 4 – Site Selection for Shellfish Aquaculture 8
  Section 5 – First Nation Territory Specific Discussions 8
  Section 6 - Food Safety and Shellfish Aquaculture 9
  Section 7 - Shellfish Aquaculture Marketing Overview 10
  Section 8 - Business Development Overview 10
  Section 9 - Shellfish Aquaculture Governance and Licensing 11
  Section 10 - Shellfish Aquaculture Project Development 11
  Section 11 - Regional Strategy for Shellfish Aquaculture Development 13

1.1 OBJECTIVES

The goal of this project was to develop a strategy and framework for First Nations shellfish aquaculture on the Central and North Coasts that will assist in the development of economic measures to support First Nations' entry into the shellfish farming industry along the coast

The goal of this project was to develop a strategy and framework for First Nations shellfish aquaculture on the Central and North Coasts that will assist in the development of economic measures to support First Nations' entry into the shellfish farming industry along the coast. The framework is intended to:

a) identify the best sites and best species for farming in each First Nations community, using existing baseline bio-physical and economic information, and;

b) establish a template for business planning through which First Nations will apply for tenure, obtain seed and equipment, train staff and management, and develop the processing, transportation, and marketing infrastructure necessary for success.

This project provides a SWOT analysis (identify Strengths and Weaknesses and examine Opportunities and Threats) and other information to assess the feasibility for coastal First Nations communities to establish and develop shellfish aquaculture operations within their traditional territories by incorporating biophysical, suitability and socioeconomic factors.

This report and strategy provides a comprehensive overview of the requirements for developing the shellfish farming industry along the whole of the Central Coast, North Coast, and Haida Gwaii/Queen Charlotte Islands land use-planning areas. The First Nation Territories included in this study include:

Kwakiutl
Oweekeno
Heiltsuk
Kitasoo
Haisla
Gitgaat
Kitkatla
Metlakatla
Lax Kw'alaams
Haida

The goal throughout the report is not to make final decisions for stakeholders but to provide options and recommendations,

The goal throughout the report is not to make final decisions for stakeholders but to provide options and recommendations, which if acted upon, will assist in the development of a viable shellfish culture industry on the Central and North Coast.

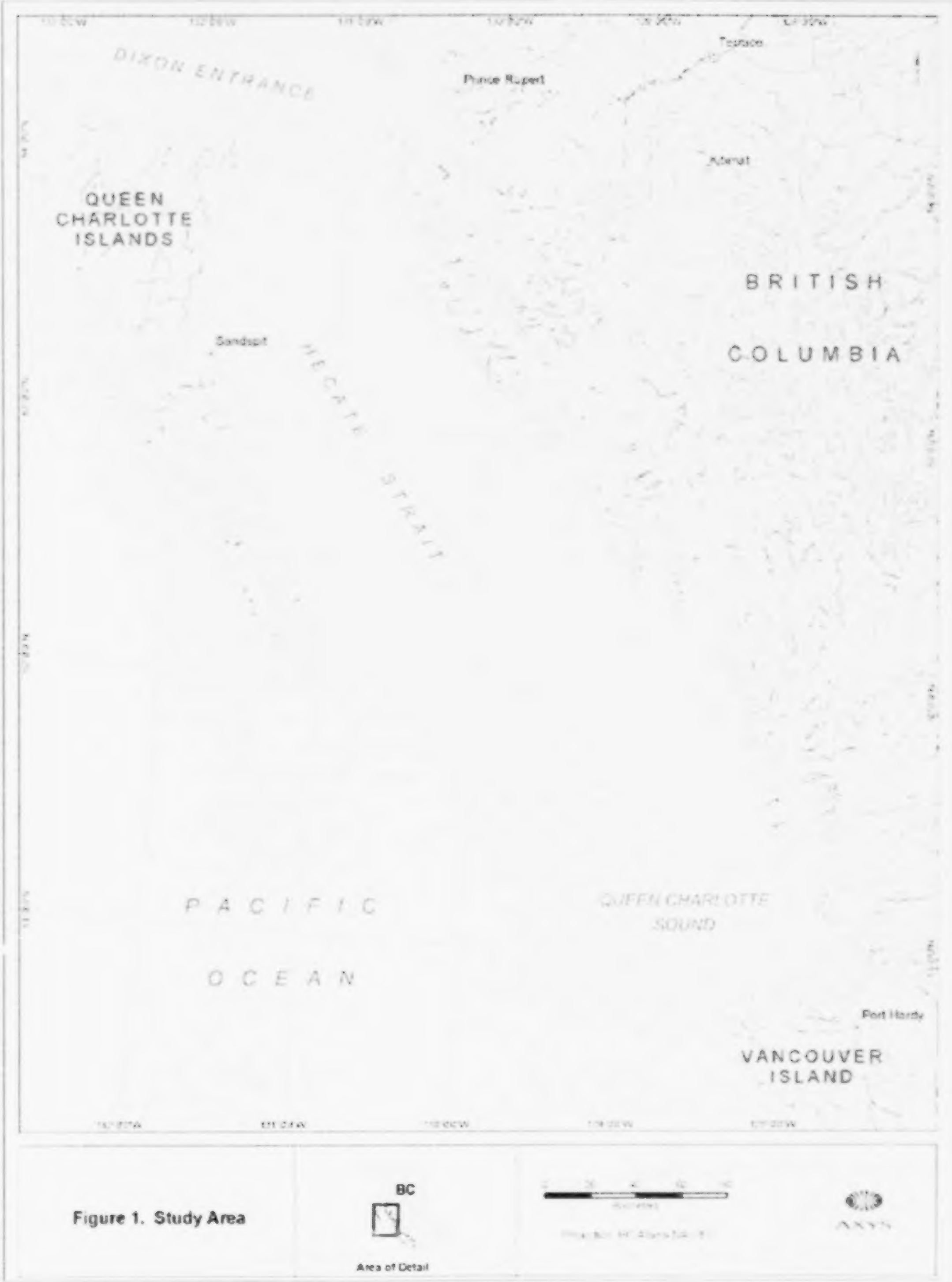
DIXON ENTRANCE
Terrace
Prince Rupert
Kitimat
QUEEN CHARLOTTE ISLANDS
BRITISH COLUMBIA
Sandspit
HECATE STRAIT
PACIFIC OCEAN
QUEEN CHARLOTTE SOUND
Port Hardy
VANCOUVER ISLAND
BC
Area of Detail

Figure 1. Study Area

1.2 BACKGROUND

The strong growth potential of the BC shellfish aquaculture industry has been confirmed in a number of recent studies, surveys and reports:

- In 1997, Coopers and Lybrand estimated that the BC shellfish industry could reach $100 million in 10 years.
- In 2001, a Canadian Aquaculture Industry Alliance (CAIA) industry survey suggested that shellfish production on both coasts would increase by 20% per year over the next five years.
- In 2002, Ecotrust estimated that the shellfish volume harvested from the Clayoquot Sound area alone would triple within the next two years.
- In 2002, the Vancouver Island Economic Developers Association commissioned a study, conducted by Kingzett Professional Services Ltd., which showed that a vision of a 50 million dollar shellfish aquaculture industry within 5 years was attainable.

The economic potential of the BC shellfish aquaculture is further enhanced by a burgeoning global demand for shellfish and other seafood products

The economic potential of the BC shellfish aquaculture is further enhanced by a burgeoning global demand for shellfish and other seafood products:per capita consumption of seafood has been steadily increasing over the last two decades. Global aquaculture production by the year 2050 is estimated to be about 105.0 million mt and represent 50% of global seafood production. Canadian aquaculture production may grow by 15% per year to 511,000 metric tonnes with a value of $3.1 billion by 2010.

As a result of the tremendous potential for growth and expansion of shellfish aquaculture, it has emerged as an important industry for coastal communities in British Columbia.

As a result of the tremendous potential for growth and expansion of shellfish aquaculture, it has emerged as an important industry for coastal communities in British Columbia. Provincial and federal government departments are focusing more attention on shellfish aquaculture as a vehicle for sustainable economic development, particularly for First Nations. Commercial shellfish aquaculture production offers the advantage of situating economic development in the heart of aboriginal communities.

The expansion of the shellfish aquaculture industry in BC is part of a provincial strategy to renew the BC seafood industry and provide an economic development alternative to First Nations. Government agencies have initiated policy and planning initiatives to support the development of the shellfish aquaculture industry into "new areas" which have demonstrated optimum biophysical capability for this business opportunity.

The opportunity therefore exists for coastal First Nations to fully participate in this process, become a key player in the development of the BC shellfish aquaculture industry

The opportunity therefore exists for coastal First Nations to fully participate in this process, become a key player in the development of the BC shellfish aquaculture industry and contribute to the provincial economy in a significant way.

Potential for First Nations Participation in Shellfish Aquaculture

A number of coastal First Nations communities have already shown significant interest in the commercial potential of shellfish culture for economic development. This interest arises not only because of the potential economic returns, but also because of the many compatibilities that exist between aboriginal communities and shellfish culture:

- The harvesting of shellfish for food and cultural purposes is a longstanding practice deeply rooted in aboriginal communities. Aboriginal communities are, therefore, very familiar with shellfish resources and already have extensive experience in harvesting them. This historical relationship provides an ideal foundation for moving into commercial development.
- Shellfish aquaculture is viewed by aboriginal communities as an environmentally sustainable industry which is therefore compatible with their environmental values.

A developed aquaculture industry has high labor demands year round and creates a wide diversity of full-time and part-time jobs.

Shellfish culture may also appeal to aboriginal leaders seeking to develop economic strategies for their communities. A developed aquaculture industry has high labor demands year round and creates a wide diversity of full-time and part-time jobs. Moreover, expanding shellfish operations into processing further increases the number and the diversity of these jobs, including an increasing number of managerial and skilled positions. Aboriginal communities are also aware that further economic benefits may be realized through the development of a vertically integrated economic program.

While shellfish aquaculture holds great economic promise for coastal First Nations communities, it is critical that industry development within these communities be based upon a sound strategic framework that will facilitate the creation of conditions for economic recovery as well as sustainable coastal and resource development.

Developmental Principles Governing Aquaculture Development

The information and recommendations contained within this report do not duplicate past efforts, but rather support and build on previous developmental work.

The information and recommendations contained within this report do not duplicate past efforts, but rather support and build on previous developmental work. In particular, principles established by the Regional Planning Committee for Shellfish Mariculture in Prince Rupert, prepared by IEC in 1999 are still valid today and have guided the research and consultation process of this project[1].

- ☐ Shellfish aquaculture development should be a priority in northern British Columbia's management of its natural and economic resources, and should be given specific policy and developmental considerations;
- ☐ Aquaculture is a legitimate use of land and water resources. It deserves equitable access to provincial resources;
- ☐ Aquaculture is a form of agriculture, and should be subject to similar rules and regulations;
- ☐ Aquaculture utilizes the aquatic environment, and should be carried out so as to protect and, where possible, enhance wild fishes stocks;
- ☐ Aquaculture should be a private sector initiative in which the principle responsibility for commercial development should rest with industry;
- ☐ Coordination of Regional, First Nation, Provincial and Federal policies is critical to successful aquaculture development;
- ☐ Aquaculture development should be consistent with government responsibilities, including public health and safety, social development, navigation, and environmental protection;
- ☐ Aquaculture development should be driven by competitive market forces;
- ☐ Research and development and technology transfer are prerequisites for industry development;
- ☐ An appropriately trained workforce is essential to aquaculture development;

- Ongoing development of a viable manufactured goods (supplies and services) sector is an essential industry component.

The report contains a total of 11 sections including this introduction.

1.3 CONTENTS OF REPORT

The report contains a total of 11 sections including this introduction. The following text describes the are the highlights of each of the sections:

Section 1 – Introduction

This section

Section 2 – Aquaculture From a Global and Provincial Perspective

This section highlights the importance of aquaculture as the fastest growing food-producing industry in the world

This section highlights the importance of aquaculture as the fastest growing food-producing industry in the world and discusses the significant contribution aquaculture is having on the economic viability of coastal communities. This section also highlights the main species cultured in BC, including Pacific oysters, Manila clams and Japanese (Pacific) weathervane scallops. The growth in commercialization of the Blue mussel (*Mytilus edulis*), the Mediterranean mussel (*M. galloprovincialis*) the Native geoduck clam (*Panope generosa*), the Northern abalone (*Haliotis Kamtschatkana*) and the European flat oyster (*Ostrea edulis*) is also discussed.

Section 3 - Production and Culture of Farmed Shellfish Species Overview

Production and culture overviews are given for 8 shellfish species.

In this section, production and culture overviews are given for 8 shellfish species. The 8 species are either being cultured in BC today, or have strong potential for culture in the near future. Each overview is designed to give a brief synopsis of the products, culture techniques, potential and issues surrounding culture for each species. A brief overview of kelp culture has been added, as this is highly compatible with shellfish aquaculture. Kelp culture utilizes many of the same site selection criteria and may potentially be a component of other shellfish culture production operations.

Section 4 – Site Selection for Shellfish Aquaculture

This section stresses the importance of considering a number of key site selection criteria, such as: biological capability, zoning and land use planning in the area, environmental sensitivity and compatibility with other nearby land uses.

The success of an aquaculture enterprise is dependent on the selection of a suitable site. In fact, poor siting and location has been a significant factor in the failure of aquaculture in some areas, and excessive environmental impacts in others. This section stresses the importance of considering a number of key site selection criteria, such as: biological capability, zoning and land use planning in the area, environmental sensitivity and compatibility with other nearby land uses. Factors affecting suitability for economic success are also explored. These factors include size of site, distance from point of land, regulatory monitoring, availability of workforce, access to supply inputs, access to markets, availability of utilities, port infrastructure, foreshore accessibility, distance from other operators and site security issues.

Section 5 – First Nation Territory Specific Discussions

A synopsis of known information regarding site capability and suitability for areas of shellfish culture interest for 10 First Nation territories on the Central and North Coast is provided

A synopsis of known information regarding site capability and suitability for areas of shellfish culture interest for 10 First Nation territories on the Central and North Coast is provided in this section. Ten versions of Section 5 of the report have been prepared with each version specific to an individual First Nation. These territory specific versions are designated confidential and have been provided to each First Nation individually. General versions of Section 5 report methodology only.

The analysis in Section 5 is limited to a designated area of "shellfish culture interest" based on nearshore portions of known traditional territories, and where available, input from First Nation representatives.

This synopsis includes:

- ❑ An overview of previously collected reconnaissance level biophysical information for oysters, scallops and Manila clam from BCMAFF studies.
- ❑ Local information from First Nations representatives for specific areas submitted as a result of this study.
- ❑ Other information available from federal and provincial sources including tenures, closure areas and known land use information

Optimal areas for deepwater and beach culture of shellfish were mapped by taking into account site capability and suitability as discussed in Section 4.0. A 20 nm buffer around the primary community in each territory was created and defined as the operational area for analysis to represent those sites which were within a reasonable travel distance from each community.

Tables were generated of waterway reaches and intertidal areas previously assessed in BCMAFF biophysical studies with good or moderate biophysical capability for each First Nation. GIS maps are presented for each First Nation Territory showing capability and suitability data assembled.

Section 6 - Food Safety and Shellfish Aquaculture

Understanding and complying with issues, regulations and monitoring programs relating to product safety is critical to the development and success of a shellfish aquaculture industry.

Given that shellfish are often consumed whole, either raw or partially cooked, the water quality of shellfish growing areas has a direct impact on the potential health to consumers. Understanding and complying with issues, regulations and monitoring programs relating to product safety is critical to the development and success of a shellfish aquaculture industry.

Marine waters from which bivalve are harvested or grown must be monitored, evaluated for pollution and classified through the Canadian Shellfish Sanitation Program (CSSP). The designation of safe growing waters, the patrolling of shellfish harvesting areas, the harvesting, processing and distribution stages of the shellfish industry are all regulated by this program. This program and the classification system is reviewed.

Shellfish toxicity and its association with exceptional blooms of phytoplankton, or Harmful Algal Blooms (HABs) pose serious problems to harvesters, seafood processors, consumers and regulatory agencies. The risks of HAB events and the biotoxin monitoring program conducted by the Canadian Food Inspection Agency (CFIA) in shellfish growing areas is reviewed.

The North Coast Water Quality & Biotoxin Program, based in Prince Rupert, coordinates biotoxin and water quality monitoring and testing services for shellfish harvesting and growing interests on the North Coast mainland and Queen Charlotte Islands. A brief overview of this important program is provided.

Bivalve shellfish may only be sold to, or processed in, a federally and provincially certified and registered facility. Those registered facilities are in good standing with the CFIA and meet all of the requirements of the Fish Inspection Regulations. This includes the requirements to have an acceptable Quality Management Program in operation. This program and the regulatory and licensing requirements for processing are reviewed.

Section 7 - Shellfish Aquaculture Marketing Overview

One of the main reasons shellfish aquaculture projects fail is they are often production, rather than market driven

One of the main reasons shellfish aquaculture projects fail is they are often production, rather than market driven. To properly address the marketing component of any shellfish aquaculture venture, this section first reviews the current marketing environment (by species) as well as provides an overview of consumer demand and shellfish consumption trends. Supply outlook and market recommendations are included for each of the main species recommended for culture in the Central and North Coast. The market environment for the major markets, US, Japan, China and Hong Kong, are reviewed. Marketing related issues, such as processing, distribution, transportation, generic marketing and trade education are discussed separately. Final market recommendations, that deal with price, partnerships and branding strategies complete this section.

Section 8 - Business Development Overview

An overview of business planning for aquaculture is provided with guidelines for determining financial feasibility and developing cash flow statements for planning

Whether it be an individual or a company, any group interested in aquaculture should prepare a business plan to anticipate and work through potential mistakes in advance. The importance of a written business plan cannot be under emphasized. An overview of business planning for aquaculture is provided with guidelines for determining financial feasibility and developing cash flow statements for planning.

It is widely recognized in the aquaculture industry that a skilled workforce is essential for competitiveness. It is important to recognize that worker availability and productivity are factors that industry can significantly influence, especially if it acts collectively. An overview of human resource issues relating to aquaculture is provided including aquaculture skill requirements, aboriginal participation in the aquaculture workforce and the need for basic business skills.

The federal, provincial and municipal governments have certain requirements for the registration of new businesses or businesses under new ownership. An overview is provided of corporate registration, licensing requirements and all the necessary permits required for operation of a commercial shellfish aquaculture enterprise.

Section 9 - Shellfish Aquaculture Governance and Licensing

It is important that prospective aquaculturists realize the implications of federal and provincial regulations and how they impact developing aquaculture operations.

Aquaculture development is dependent on a harmonization of federal and provincial policies and regulations. The province has title to most public lands in BC and the legislative power to manage and sell those lands. Federal jurisdiction resides over conservation and protection of fisheries resources, use of federal public property, seacoast and inland fisheries, navigation and shipping and First Nation's issues. Often, there is an overlap between federal and provincial legislative powers. The complex matrix of overlapping federal and provincial government responsibilities leads to excessive regulatory requirements and uncertainty. It is important that prospective aquaculturists realize the implications of federal and provincial regulations and how they impact developing aquaculture operations.

To facilitate this, an overview is provided of the government administration of the industry. A detailed summary is provided of the BC shellfish aquaculture application & licensing process administered by Land and Water British Columbia. Overviews are also provided of the Canadian Environmental Assessment Act, its role in shellfish aquaculture applications and the BCMAFF Environmental Code of Practice

Section 10 - Shellfish Aquaculture Project Development

For First Nations shellfish aquaculture projects to succeed, the driving force behind any development needs to come from within communities, not government or other groups

For First Nations shellfish aquaculture projects to succeed, the driving force behind any development needs to come from within communities, not government or other groups, since the latter option may be seen as setting up projects that would inevitably fail.

At a community level, it is essential for stakeholders and other community members to be fully aware of what is involved in shellfish aquaculture, to have a realistic expectation of the rewards and returns as well as the long term commitment in time and effort needed to achieved successful outcomes. An overview of internal factors that must be considered prior to engaging in aquaculture development is provided.

Prior to engaging in any sort of shellfish aquaculture business development First Nations groups should establish basic business goals and employ legal advice in determining what sort of formal business structure will best suit their needs. A brief review of common business structures is provided.

The recent growth and trials of the Newfoundland mussel culture industry is profiled. The Newfoundland mussel culture industry suffered severe growth pains during its rapid development during the last five years. The Newfoundland industry has subsequently identified many of the causes and solutions to the industry issues it was/is facing. The lessons learned should be used to guide development in Central and Northern British Columbia to prevent similar mistakes from repeating themselves.

To be successful, development projects will often require outside technology, expertise, and investment capital to grow.

New business investment and development is a key strategy to achieving the goal of building sustainable communities and local economies. While some institutional and government support may be realized, project development cannot always be developed solely from within. To be successful, development projects will often require outside technology, expertise, and investment capital to grow. Attracting new businesses and business recruitment, also known as the attraction of inbound investment, is about bringing new monies into communities from companies or individuals to establish new businesses or relocate or expand existing businesses.

Inbound investment may be a critical way to bring investment, management, and technology transfer to economically viable aquaculture development projects. As it is imperative that First Nations considering this route understand how joint ventures work, a summary of joint ventures is provided.

Section 11 - Regional Strategy for Shellfish Aquaculture Development

The goal of this section is to summarize the information provided in the previous sections and present it in such a way as to provide guidance that will lead to informed decision making processes by both First Nations and Government stakeholders alike.

The goal of this section is to summarize the information provided in the previous sections and present it in such a way as to provide guidance that will lead to informed decision making

The goal is not to make decision for stakeholders but rather to provide recommendations that should be implemented in order to create a viable and sustainable shellfish culture industry on the Central and North Coast.

The components of the regional strategy include:

- A SWOT analysis which provides an overview framework or the Strength and Weaknesses of the current situation and the Opportunities and Threats that face the development of a viable shellfish aquaculture industry on the north Coast.
- An evaluation framework for the 9 species groups that are discussed in throughout the previous sections.
- A regional development strategy framework, which presents a series of concurrent actions, which must occur for the logical development of an industry. These action steps are presented in relative order.
- A summary of the major components of the regional development strategy framework and a series of individual recommendations appropriate to each component.

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[1] IEC Collaborative Research and Development Ltd. 1999. A Strategic development plan for shellfish aquaculture in northern coastal British Columbia. Prepared for Regional planning committee for shellfish Mariculture c/o Skeena Queen Charlotte Regional District.. Prince Rupert 91p + app.

2.0 Aquaculture from a Global and Provincial Perspective

Table of Contents

2.1 Introduction 2
  Global Aquaculture Trends 3
  What and Where 5
  Global Molluscan Shellfish Culture 8
  Relationship of BC Culture to World Production 9
  Relationship of BC Shellfish Culture to North American Production 9
2.2 Production Overview of the BC Shellfish Culture Industry 11
  Species Under Culture 11
  Production Trends Within the BC Industry 12
  Locations of Tenures and Production 2001 13
  Current State of Production Values 14
2.3 Structural Overview of the BC Shellfish Culture Industry 17
  Workforce 17
  Economic Contribution and Impact 17
  Industry Structure 18
2.4 Potential of the BC Shellfish Culture Industry 19
  Global Growth Predictions 19
  Canadian Growth Projections 20
  BC's Potential 21
  Provincial Shellfish Projections 21
  Canadian Aquaculture Industry Alliance Industry Survey, 2002 21
  Status of the Shellfish Development Initiative (SDI) 23
  Potential for First Nation Communities 24

2.1 INTRODUCTION

Aquaculture is recognized as the only means by which increasing world demand for seafood will be met in the future.

Globally, seafood industries are shifting from traditional wild capture fisheries for seafood products, to the commercial cultivation of farmed species. Aquaculture is recognized as the only means by which increasing world demand for seafood will be met in the future.

By definition, aquaculture is the: Culture of aquatic organisms, including fish, molluscs crustaceans and aquatic plants. Culture implies some form of intervention in the rearing process to enhance production such as regular stocking, feeding, protection from predators, etc. Culture also implies individual or corporate ownership of the stock being cultivated.[1]

Aquaculture comprises diverse systems of farming aquatic animals and plants in fresh and marine waters. A wide variety of animal and plant species are produced through aquaculture including: finfish, shrimp, prawns and crabs; oysters and mussels; as well as seaweeds and other aquatic plants. Culture practices are conducted in a range of aquatic environments (freshwater, brackish, and marine) and temperatures (cold, temperate, and warm).

However, aquaculture is a sector that is predominantly rural and in the face of increasingly threatened wild fish stocks, it contributes significantly to providing food security. Aquaculture plays a key role in providing food fish to the world's population and enables employment and income generation, which in turn helps alleviate poverty and assists rural livelihoods.

Aquaculture is characterized not only by its very diverse array of cultured products, but also by a wide range of management practices. At one extreme are those of large scale industry, which are typically capital intensive and market driven and have high primary resource inputs. At the other end of the spectrum are the rural, low-input practices involving local communities. There are many intermediate management practices where one or two species are cultured in rural areas and the majority of the product is sold to urban and export markets.

The world per capita fish consumption has been growing since the 1960s.

The world per capita fish consumption has been growing since the 1960s. Consumption has varied among continents and countries within each continent and, on average, has always been higher in richer than in poorer countries. Although aquaculture originated at least two millennia ago, it was only since the latter part of the 20th Century that it began to make a significant contribution to overall human food supplies, and it is now seen as an important sector for the supply of animal protein[3]. The increase in the importance of aquatic food is a reflection of the increase in world fishery production.

Global Aquaculture Trends

Starting from an insignificant total production, inland and marine aquaculture production grew by about 15 percent per year between 1950 and 1969 and by about 8 percent per year during the 1970s and 1980s, and it has increased further to 10 percent per year since 1990. To meet the ever-increasing demand for fish, aquaculture has expanded very rapidly and is now the fastest growing food-producing industry in the world[4].

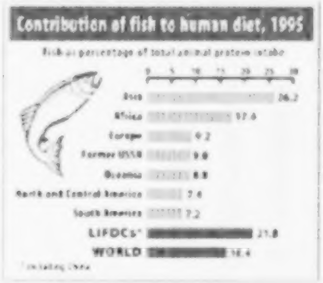
Aquaculture is now the fastest growing food-producing industry in the world.

Since 1988, almost all of the increased availability of food fish has been due to aquaculture and it is generally accepted on a global scale that capture fisheries have reached the maximum sustainable yields. Aquaculture currently accounts for about one- third, or 40 million metric tonnes (mt), of the annual world fisheries production of 120 million mt.

The contribution of aquaculture to world food supply of aquatic products has been increasing over the past 15 years, growing from 12 to 28 percent of total production between 1984 and 1997[5]. Total aquaculture production increased from 10 million mt of fish in 1984 to 30.9 million mt in 1998. In 1998, total world production of finfish, crustaceans, (e.g. shrimp, prawns, crabs), and molluscs, (e.g. clams, oysters, mussels), from capture fisheries and aquaculture reached 117.2 million mt[6]. The total value of aquaculture production reached US$ 52.5 billion in 1998.

The total value of aquaculture production reached US$ 52.5 billion in 1998.

The total food fish supply has been growing at a rate of 3.6 percent per annum since 1961, while the world's population has been expanding at 1.8 percent per annum. The proteins derived from fish, crustaceans, and molluscs account for between 13.8 and 16.5 percent of the animal protein intake of the human population according to the Food and Agriculture Organization (FAO) of the United Nations (1997). Aquatic products will be in greater short supply as the domestic and international demand for both high and low valued species increases due to rising populations[7]. Many studies forecast that per capita fish intake will continue to increase worldwide over the next three decades, and that most of this increase will result from economic prosperity.



The potential of aquaculture to meet the challenges of food security and to generate employment and foreign exchange is demonstrated by the rapid expansion of this sector, which provides an acceptable supplement to wild fish and plants. Further growth of aquaculture in the food sector is anticipated as awareness of the positive effects that fish consumption has on health and well being increases, especially in developing countries.

FAO (2000) estimates that by 2030, over half of the fish consumed by the world's people will be produced by aquaculture, and a growth rate of 11% per year has aquaculture on a pace to surpass beef production by 2010. The global expansion of aquaculture continues to outpace growth in capture fisheries sector.

By 2030, over half of the fish consumed by the world's people will be produced by aquaculture.

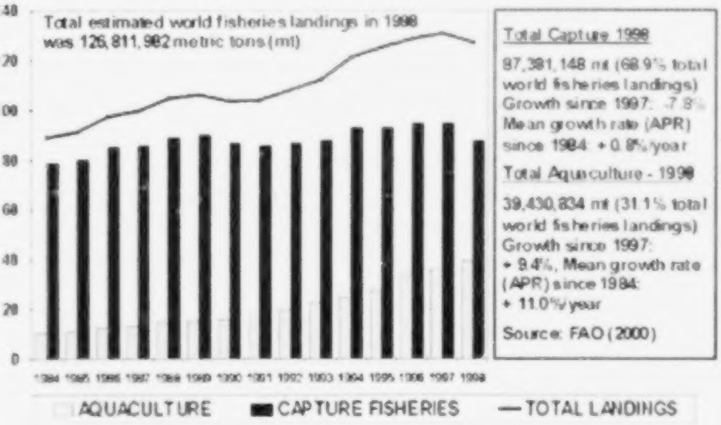


Figure 1. The contribution of capture fisheries and aquaculture to the total aquatic food supply and the total world fisheries landings in 1998. Source: FAO

Aquaculture is making an increasing contribution to rural economies. In some countries aquaculture now has a greater economic value than the conventional capture fisheries.

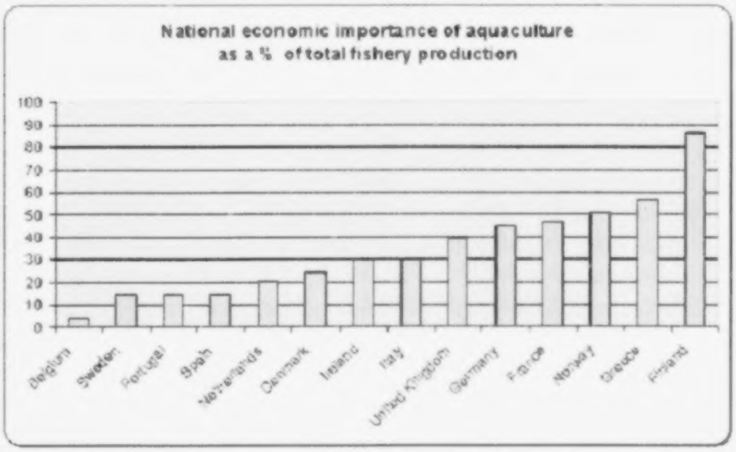


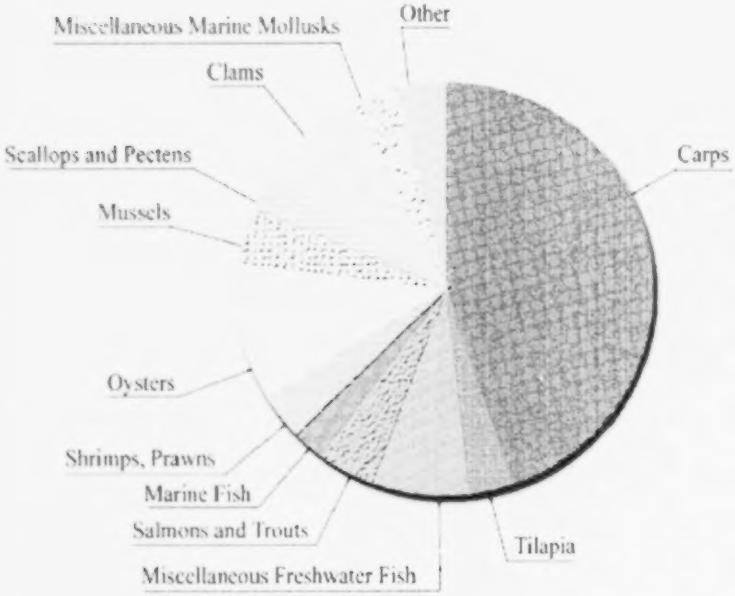
Figure 2. The contribution of aquaculture to the total fisheries production among European Nations.

Source: European Commission http://www.feap.info/economics/ruraleconomy/default_en.asp

What and Where

Half of all aquaculture production is finfish, a quarter is aquatic plants and the remaining quarter is made up of crustaceans (e.g. shrimp, prawns, crabs) and molluscs such as clams, oysters and mussels. Overall, these species represent a relatively small portion of the total aquaculture production (Fig. 2).

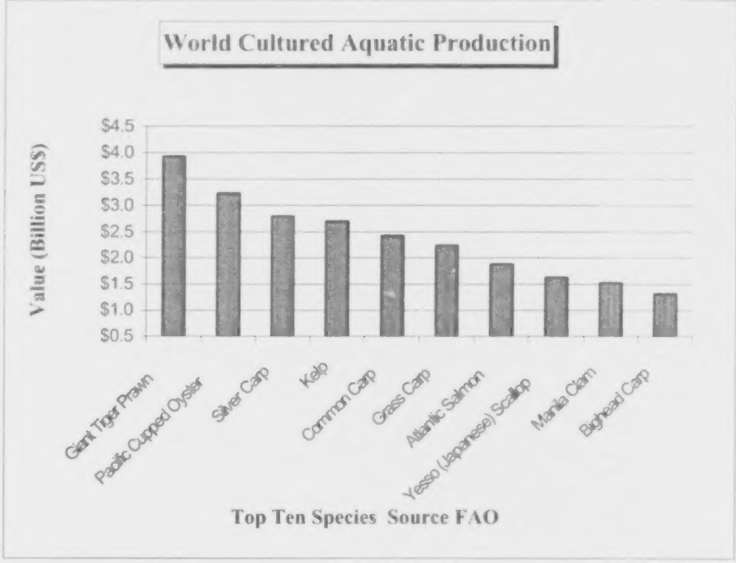
Figure 3. The proportion of total aquaculture production accounted for by species groups[2].



All of the top ten species over the last decade represent organisms low in the food chain (i.e. they are either filter-feeders, plants or finfish which are considered herbivores and omnivores). In 1988, the ten species that were produced in the highest quantity included five finfish, three aquatic plants, and two molluscs, where the top four species exceeded 1 million mt. By 1997, five finfish, three molluscs, and two aquatic plant species made up the top ten. The top ten species produced by value are shown in Figure 3.

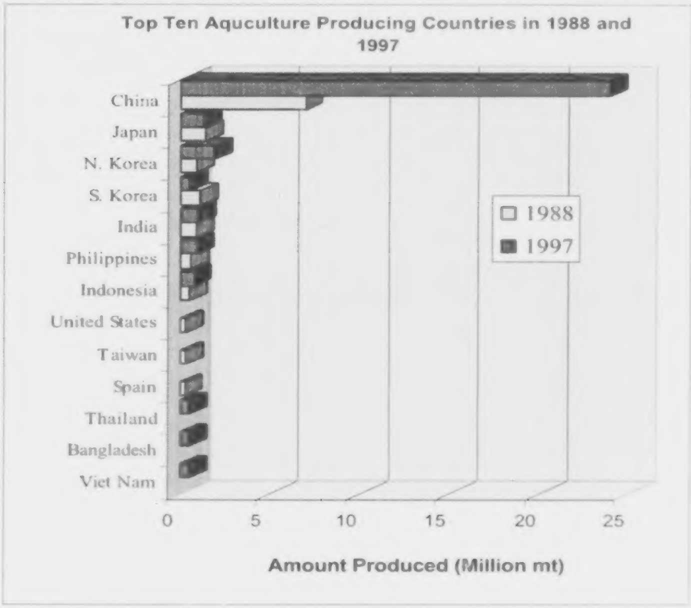
Figure 4. The top ten aquaculture species by value for 1998.

Source FAO



In 1997, China, Japan and North Korea were the top producing countries, together accounting for more than half of the total aquaculture production by weight (Fig. 4). While China produced 17.9 million mt of food fish through aquaculture, the rest of the world only produced 8.9 million mt. China's contribution to Asian and global production in 1997 was 74 and 67 percent, respectively.

Figure 5. The top ten aquaculture producing countries in 1988 and 1997.



Of the low-income food deficit countries (LIFDCs), China and other Asian countries dominate, because it has been stated that they have been much more active in promoting aquaculture, particularly for subsistence.

While Asia, America and Europe have seen an expansion in aquaculture production, Africa has been slow to develop its potential. Unlike Asia, Africa has little tradition in aquaculture and has been affected by a number of external problems. This has prevented Africa from having proper management and development despite investment. Nevertheless, aquaculture production in Africa has risen from 37,000 tonnes in 1984 to 189,000 tonnes in 1998, the majority of which are freshwater fish, including carp and tilapia.

Of the ten top producers of food fish through aquaculture, Japan has the highest per-capita consumption in the group. The FAO (2000) reported that Asia is the center of world fish consumption (accounting for two-thirds of the total at the end of the 1990s) and what happens there will determine global developments. FAO is projecting economic growth in Asia over the next decade sufficient to stimulate both demand and production in that part of the world.

Table 2.1 ***The top 15 aquaculture producing countries in 1998. (Tonnage, Annual Percent Rate of growth and Value USD$)***

Source FAO 2000

1. China	**27.07 mmt (68.6%)**	**APR +16.2/+12.7%**	**$ 25.4 billion**
2. India	**2.02 mmt**	**APR +11.2/+9.0%**	**$ 2.22 billion**
3. Japan	**1.29 mmt**	**APR +0.5/-3.7%**	**$ 4.13 billion**
4. Philippines	**0.95 mmt**	**APR +5.5/-0.3%**	**$ 0.64 billion**
5. Indonesia	**0.81 mmt**	**APR +7.2/+4.7%**	**$ 2.15 billion**
6. Korea, REP	**0.80 mmt**	**APR +1.2/-23.5%**	**$ 0.77 billion**
7. Bangladesh	**0.58 mmt**	**APR +12.7/+13.9%**	**$ 1.49 billion**
8. Thailand	**0.57 mmt**	**APR +13.0/+3.1**	**$ 1.81 billion**
9. Viet Nam	**0.54 mmt**	**APR +12.3/+5.7**	**$ 1.36 billion**
10. Korea	**0.48 mmt**	**APR -2.9/-1.6%**	**$ 0.30 billion**
11. USA	**0.44 mmt**	**APR +2.4/+1.5%**	**$ 0.78 billion**
12. Norway	**0.41 mmt**	**APR +23.6/+11.3%**	**$ 1.1 billion**
13. Chile	**0.36 mmt**	**APR +33.3/-3.6%**	**$ 1.0 billion**
14. Spain	**0.31 mmt**	**APR +1.8/+31.1%**	**$ 0.28 billion**
15. France	**0.27 mmt**	**APR +2.7/-4.7%**	**$ 0.61 billion**

Global Molluscan Shellfish Culture

Approximately 86 percent of the contribution to total aquaculture and shellfish production originates from filter-feeding molluscs such as oysters, mussels, scallops, and cockles. Fifty-eight species of molluscs are cultured globally, and the total production is about 8.6 million mt. However, the production exceeded 50,000 mt (in 1997) for ten species only (two oysters, five mussels, two clams and cockles, and one scallop species)[8]. The most valuable and fastest expanding species are being grown in North and South America, Europe and Asia. Asia leads global mollusc culture, with its contribution growing steadily from about 76 percent in 1988 to nearly 90 percent in 1997.

Fifty-eight species of molluscs are cultured globally.

The culture of predominantly high value shellfish such as the Japanese scallop (*Patinopecten yessoensis*) and the Pacific oyster (*Crassostrea gigas*) more than doubled the world share, in terms of value. In recent years, the most harvested species has been the Pacific oyster, which grossed 3.4 million mt in 1998. The Pacific oyster was the number one aquaculture species in four out of the five years to 1998. Manila clams are also important making up 18% and 24% of the total mollusc weight and value, whereas only 5 percent of the world mollusc production is mussels. More than 9 out of every 10 oysters consumed are now products of aquaculture and 4 out of every 5 mussels and 3 out of 4 scallops are cultured[9].

The Pacific oyster was the number one aquaculture species in four out of the five years to 1998.

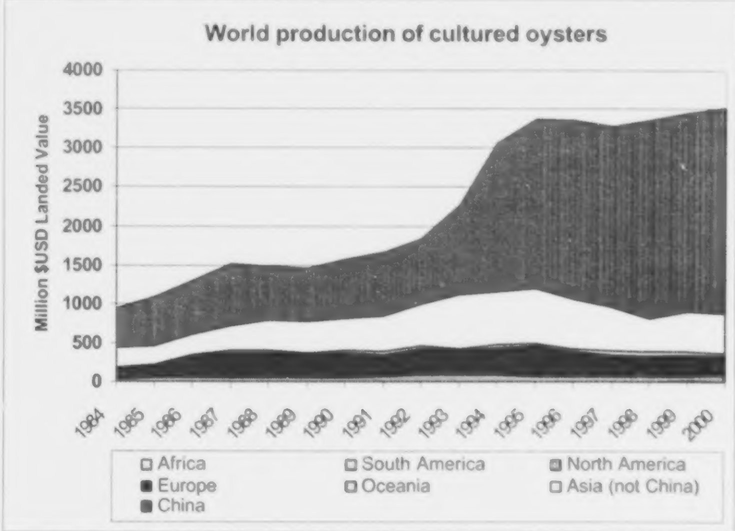


Figure6. Global oyster culture 1984 – 2000. (Source: FAO FishStat 2002)

China dominates the culture of oysters with a value of US$ 2.6 billion in 2000. Of the remaining US$ 892 million of production 59% is still with Asia as shown in the breakdown by region (Figure 6).

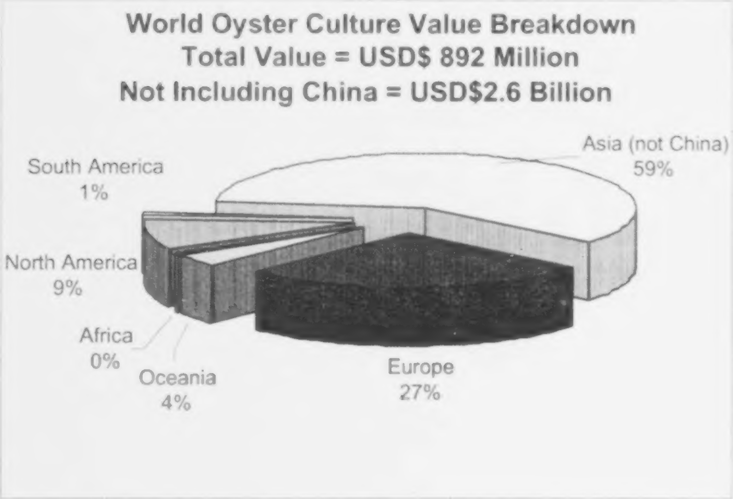


Figure 7. World oyster culture value breakdown by region in 2000.

(Source: FAO FishStat 2002)

Relationship of BC Culture to World Production

British Columbia's contribution to global production of farmed shellfish is miniscule at best in global terms. British Columbia ranks as the 12th largest single producer of Pacific oysters but only produces 0.12% of production value for this species. BC is the 6th largest producer of Manila clams with only 0.14% of world value, and the 9th largest producer of cultured scallops, with only 0.01% of value. BC does not yet rank at all for production of cultured mussels, although eastern Canada is ranked 8th in the world. In addition, BC does not rank in cultured Abalone production.

Relationship of BC Shellfish Culture to North American Production

In 2000 British Columbia accounted for 5.0% of North American landed oyster culture value according to FAO.

In 2000 British Columbia, accounted for 5.0% of North American landed oyster culture value according to FAO. The North American oyster culture industry is dominated by the US Atlantic oyster culture industry (58% in 2000), which has been highly variable during the period shown on the following figure. The US Pacific coast accounted for approximately 29% of the industry value in 2000 and has been more stable during the last decade. The value of oysters from Atlantic Canada was reported by FAO as approximately 7.6% of North American value in 2000, although this value may be over-represented (Fig. 12).

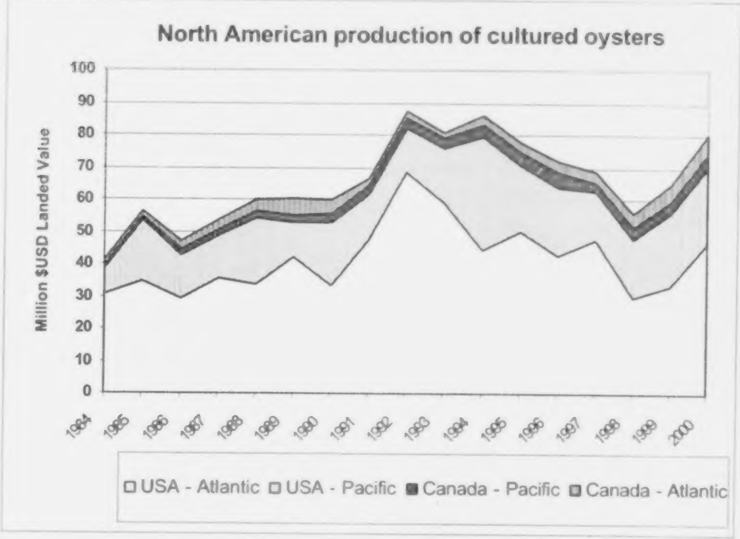


Figure 8. North American production of cultured oysters 1984-2000.
(Source:FAO FishStat 2002)

2.2 PRODUCTION OVERVIEW OF THE BC SHELLFISH CULTURE INDUSTRY

Species Under Culture

The three main species of shellfish cultured in British Columbia are Pacific oysters, Manila clams and Japanese (Pacific) weathervane scallops. All three are non-indigenous species introduced intentionally or unintentionally from Japan.

- ☐ The **Pacific oyster** (*Crassostrea gigas*) was first introduced into the Pacific Northwest about 1900 and introductions continued until World War II. This species is barely established in British Columbia, breeding with regularity in only three small areas, as the waters of British Columbia are generally cooler than the species natural breeding range.
- ☐ The **Manila clam** (*Venerupis philippinarum*) was accidentally introduced into British Colombia in the mid-1930s with oyster seed from Japan and it is now well established. It was the subject of a large boom and bust wild fishery, which is managed by area restrictions and limited-entry participation.
- ☐ The **Japanese weathervane scallop**, (*Patinopecten yessoensis*) marketed as the "Pacific scallop" was introduced from Japan by a joint program of the Department of Fisheries and Oceans and the British Columbia provincial government during the 1980s. Imported broodstock were held in quarantine and bred. Successive generations of offspring were used to initiate a scallop culture industry in the province.

Shellfish growers rely primarily on hatchery-produced seed for the culture of all three species. Clam growers also use strategies to enhance the number and increase the survival of clam larvae, which settle out on culture beds. However, most of the oyster and clam seed used in British Columbia is imported from the United States.

Consequently, in British Columbia efforts are underway to commercialize culture of the Blue mussel (*Mytilus edulis*), the Mediterranean mussel (*M. galloprovincialis*)the Native geoduck clam (*Panope generosa*) and the Northern abalone (*Haliotis Kamtschatkana*). The European flat oyster (*Ostrea edulis*) is also grown in British Columbia in small amounts.

A full description and summary of each species and its opportunity for the Central and North Coast of British Columbia is discussed in Section 3, and evaluation framework is provided in Section 11.

Production Trends Within the BC Industry

From the beginnings of the shellfish aquaculture industry through to the 1970s, the industry generally operated as family or 'lifestyle' businesses, often under-utilizing the existing land-base and employing a ranching philosophy, relying on inconsistent collection of seed stocks in the wild. From the late 1970s through to the present, a number of factors have led to significant growth in the industry.

These have included:

- ☐ production improvements through research, technology transfer, and developments such as inexpensive and consistent hatchery seed stocks, mechanization, new suspended culture technologies, etc.;
- ☐ a shift in the structure of the industry to younger companies with production and business oriented approaches to aquaculture;
- ☐ a shift in regulatory and agency focus to recognize the importance of and the potential of aquaculture in the agri-food and seafood sectors;
- ☐ global air freight services opening up strong international export markets for world class cultured products; and
- ☐ diversification of the industry into new species and higher value product forms.

In general, a shift in production techniques is occurring and can be anticipated in the near future as oyster growers continue to increase the development of deep-water culture techniques. Without the increase of new ground for intertidal culture, the amount of intertidal area being used for oyster culture may decrease as more areas are converted to clam culture. This decrease in area may not be reflected in overall intertidal production as growers continue to intensify production on existing tenures not used for clams.

The majority of production increases in oyster production can be expected to occur from the development of deep-water culture areas, which allow much more intensive levels of production and increased growth rates. Deep-water production may be more readily mechanized and more advanced production techniques are available as well.

As improving husbandry techniques may rely on a combination of intertidal and deep-water culture, the use and availability of intertidal culture areas will continue and increase in importance.

Locations of Tenures and Production 2001

Currently, there are 482 licensed shellfish tenures occupying 2114 hectares (ha) in British Columbia, not including a 375 ha experimental subtidal scallop culture tenure south of Denman Island in the Strait of Georgia. With the exception of one farm in the Queen Charlotte Islands (Skidegate Inlet) and one south of Prince Rupert (Humpback Bay, Porcher Island, currently all tenures are located within the Strait of Georgia or around Vancouver Island.

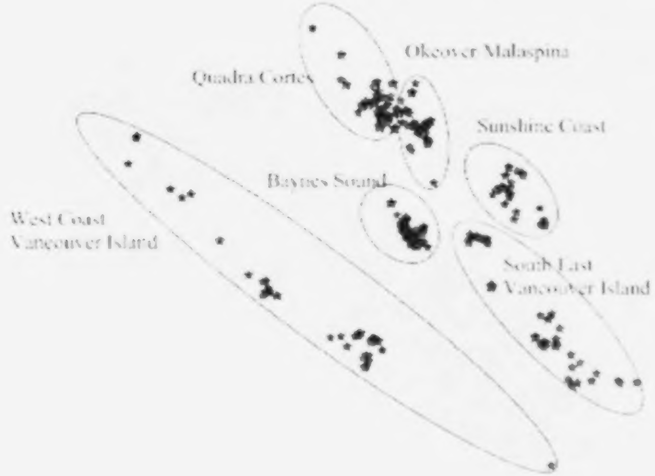

Okeover Malaspina
Quadra Cortes
Sunshine Coast
Baynes Sound
West Coast
Vancouver Island
South East
Vancouver Island

Figure 9. Tenure locations within the Strait of Georgia and around Vancouver Island.

Current State of Production Values

The BC shellfish aquaculture industry is concentrated primarily on the production of Pacific oysters and Manila clams. Virtually all of the commercial harvest of BC oysters is farmed while commercial culture of clams is steadily increasing. During the 1990s, farmed production of Manila clams averaged 25% of all clam production (including wild fishery). The wholesale value of the industry in 2000 was approximately CAN$20 million (Fig. 16).

During the 1990s, the harvest of BC farmed shellfish grew considerably. Shellfish aquaculture production stood at 4600 tonnes in 1990 and was 6700 tonnes at the end of the decade, a rise of 46% over nine years.

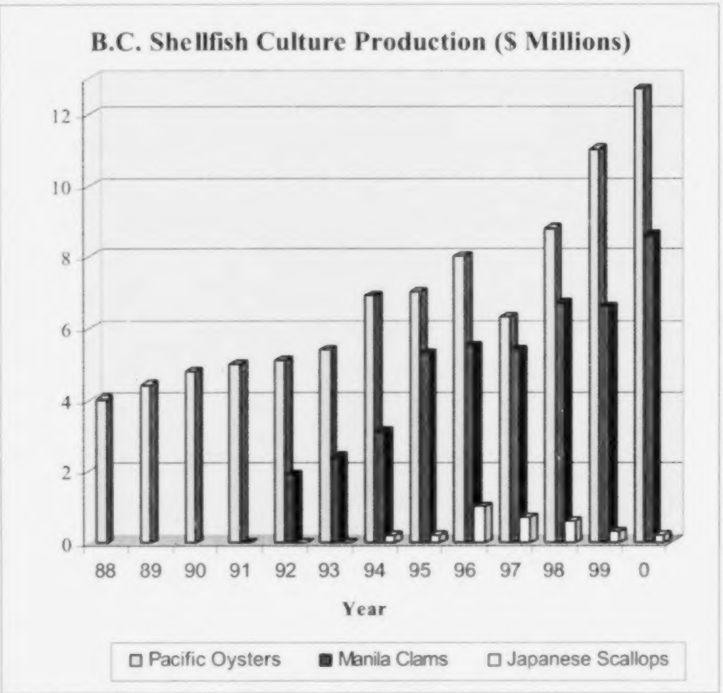


Figure 10. The total value of shellfish culture production in BC (wholesale) 1988-2000.

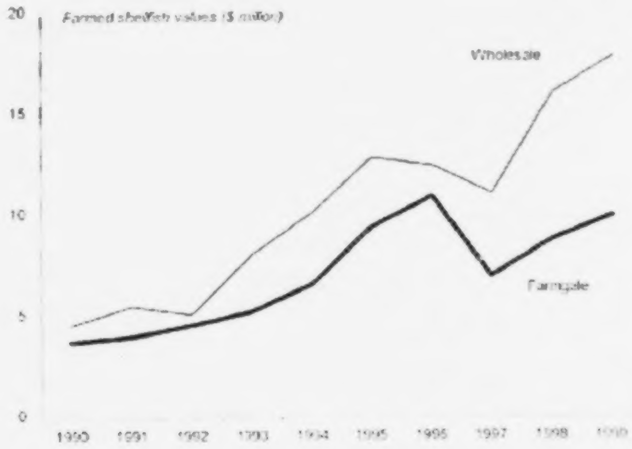
The production of BC farmed oysters averaged 4900 tonnes during the 1990s and reached 5.8 thousand tonnes in 1999. Oyster production was 28% higher at the end of the decade than in 1990.

Preliminary estimates for 2001 indicate that current production is at 1.8 million dozen single oysters per year and 128,000 gallons of shucked oyster meats with a combined farmgate value of just over CAN$ 7 million[10]. This pales in comparison to the estimated CAN$ 5 billion and CAN$ 2.3 billion value of global production of Pacific oysters and Manila clams respectively.

Commercial production of farmed clams in 1990 was just 39 tonnes. This value increased to 900 tonnes by 1999 and accounted for 13% of farmed shellfish production in that year by weight, but made up almost 40% of farmgate value. Over this period, farmed clams accounted for an increasingly large share of the farmgate and wholesale value of the industry as commercial production of clams increased. The increase in the products share of the total value of production also reflects the higher value received for farmed clams.

During the last decade, values of farmed shellfish also grew sharply, in dollar terms; farmgate value was CAN$ 3.8 million at the beginning of the decade and had reached CAN$ 10.0 million by 1999 (Fig. 17). The wholesale value rose from CAN$ 4.6 million to CAN$ 17.9 million[11] (290%), increasing faster than farmgate values (166%) during the last decade. In 1990, the wholesale value of BC farmed shellfish was just 21% above farmgate receipts, by the end of the decade; however, wholesale value was 179% of aquaculture farmgate sales.

Figure 11. The farmgate and wholesale values of BC farmed shellfish 1990-1999.



Source: BC Ministry of Finance and Corp. relations 2001

Compared to wild shellfish species (e.g. geoduck), BC's farmed shellfish is a considerably lower priced product. During the 1990s, the landed price of farmed shellfish averaged $1.25/kg, which was less than the 3.98/kg received for wild species. Nevertheless, the farmgate price for BC cultured shellfish increased by 82% over the decade with farmed clams receiving considerably higher prices than oysters (1999 Clams = $4.22/kg average vs. Oysters = 1.03/kg average). Export prices for oysters in 1999 were 3.9 times farmgate price whereas clam exports ($6.05) averaged 2.2 times the farmgate price.

2.3 STRUCTURAL OVERVIEW OF THE BC SHELLFISH CULTURE INDUSTRY

Workforce

Shellfish aquaculture provides well-paying, permanent, year round employment in rural and coastal areas where jobs are scarce and the percentage of displaced resource workers are high. Given that the skill sets, lifestyle and location are compatible with the fishing industry, it is clearly a realistic opportunity for displaced fishers, including First Nations.

It is estimated that there are currently 700-1000 direct jobs that can be attributed to the BC shellfish aquaculture industry.

While automation and improved technology has been increasing in the industry (e.g., hydraulic lifts for harvest and product handling), most shellfish culture is still highly labour intensive. It is estimated that there are currently 700-1000 direct jobs that can be attributed to the BC shellfish aquaculture industry, and workers under the age of thirty hold approximately 50% of those jobs[12].

Compared to other industries, a higher percentage of each dollar made in shellfish farming goes to jobs. From a percentage basis, this industry spends more on wages than other sectors such as terrestrial agriculture and fishing.

According to Praxis Research & Consulting Inc.[13], new occupations are being created in the aquaculture industry due to technological change, development of new species and production of value added products.

The BC shellfish aquaculture industry has evolved to date with little in the way of formal training programs.

Economic Contribution and Impact

Estimates of the contribution of the BC shellfish sector to the provincial economy were identified by Coopers and Lybrand (1997)[14]. A provincial economic multiplier for shellfish farming was estimated through expenditure data obtained through a survey of producers and processors. The output and Gross Domestic Product (GDP) multipliers for shellfish farming were found to be higher than in agriculture and related services, including fishing and the food and beverage industry.

Cormier and Tillapaugh (1998)[15], estimated spin-off employment generated by the aquaculture industry. The authors suggest that two-thirds of an indirect job is created for every direct job in the aquaculture industry. The nature of the shellfish farming industry is such that this spin off employment is located in rural coastal communities, rather than the larger urban centers.

2/3 of an indirect job is created for every direct job in the aquaculture industry.

As stated the current projection for direct employment in the BC shellfish aquaculture industry is approximately 700-1000. Given the employment multiplier, developed by Cormier and Tillapaugh (1998) one might hypothesize that there could be 600 indirect jobs in BC related to shellfish aquaculture.

Shellfish aquaculture clearly has a significant impact on related supply and service industries in coastal BC. Shellfish operations use construction and transportation services, boat repair and maintenance services, business, financial management, and consulting services, as well as a variety of technical services such as laboratories. Aside from service, the industry purchases large numbers of other goods and equipment. As the industry increases its technology, increased sales and development of specific equipment and technologies can also be expected.

Industry Structure

While it is anticipated that the industry is poised for a structural reorganization to take place (increased level of foreign ownership and presence of multinational companies), the great majority of shellfish operators are still small companies, many of which are family owned.

The great majority of shellfish operators are still small companies, many of which are family owned.

Processing

In a recent shellfish market survey conducted by Ecotrust Canada (2002)[16], it was determined that there are a total of 31 seafood processors currently licensed to process and ship BC shellfish. On Vancouver Island, 4 or 5 (of a total of 10) companies process the vast majority of the farmed production. These 10 companies process primarily oysters (shuckers and single oysters) as well as clams. One company, Fanny Bay Oysters handles more than 50% of the Island's current oyster shucking activity, and only two companies process the majority of culture clams and oysters. There is also an indication that some of the larger growers are now integrating their operations with processing.

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2.4 POTENTIAL OF THE BC SHELLFISH CULTURE INDUSTRY

Global Growth Predictions

Globally, the aquaculture industry is the fastest growing food sector and BC is positioned to reap the benefits of this dynamic and expanding sector.

The aquaculture industry is the fastest growing food sector and BC is positioned to reap the benefits of this dynamic and expanding sector.

A Department of Fisheries and Oceans background paper (1999)[18] contains the following projections of world demand for seafood and global aquaculture production:

- ☐ The United Nations Food and Agriculture Organization (FAO) projects world demand for fish and seafood will grow steadily from under 101 million tonnes in 1993 to 120 million tonnes by 2010.
- ☐ According to FAO, world aquaculture production was projected to reach 35 million tonnes by the year 2000, an increase of 21% over 1995 levels (this is considered by FAO to be a conservative estimate). At this volume of production aquaculture would contribute the equivalent of almost 30% of global fisheries production and more than 45% of its value.

This projection of rapid growth concurs with other projections including those made by fisheries and aquaculture specialists at the International Conference on Sustainable Contribution of Fisheries to Food Security, held in Kyoto, Japan in 1995. The assembled experts estimated future aquaculture production levels by the year 2010. Two growth scenarios were developed (low and high growth).

Under their high growth scenario, aquaculture production would reach 55 million mt by the year 2010. Under their extreme low growth scenario, production would still reach 37 million mt. Given the favourable long-term demand outlook and actions being taken by governments around the world to foster continued aquaculture development and remove some of the constraints to sustainable growth, actual production in the year 2010 will likely be closer to the high end of the scenario. To date, every estimate of future global aquaculture growth has proven to be too conservative. For a long-term scenario, production by the year 2050 was estimated by the Kyoto conference to be about 105.0 million mt.

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Canadian Growth Projections

When Brian Tobin was the Minister of Fisheries and Oceans, he summed up the benefits of Canadian aquaculture with the following statement:

> *Aquaculture is technology based, and is highly tuned to changing consumer trends. And by matching the capabilities of science and technology, with the advantages of our own pristine environment and the wealth of our natural resources, this industry is one of the most promising new industries in Canada today*[19].

In 1995 Canada ranked 27th in the world, accounting for only 0.2% of global aquaculture production.

A Department of Fisheries and Oceans background paper (1999) shows that Canada is a small player on the world stage. In 1995 Canada ranked 27th in the world, accounting for only 0.2% of global aquaculture production. The report also indicates that Canada has not kept pace with the growth in world aquaculture production.

However, production and value in the Canadian aquaculture industry have grown rapidly and growth rates appear to be increasing (i.e., 11% per year from 1991 to 2000 and 14% per year from 1996 to 2000). Not only will production and value grow for existing farmed species, but new species will begin to contribute significantly.

According to the Department of Fisheries and Oceans 1999 literature, the comparatively small size of the aquaculture industry in Canada is not commensurate with it's potential, given that Canada has an abundance of natural resources ideally suited to the sector. In addition, Canadians have acquired internationally recognized technical and management expertise in the sector, and have developed state-of-the-art facilities for the production of high quality cultured seafood.

If Canada can translate its significant advantages into industry growth, it has the potential to be a world leader in aquaculture.

Canada's geographical setting is also advantageous as we have easy access to the vast Pacific Rim and North American fish and seafood markets. If Canada can translate its significant advantages into industry growth, it has the potential to be a world leader in aquaculture.

Production projections made by industry experts at the Office of the Commissioner for Aquaculture Development (OCAD), 2001 "Think Tank" indicates that Canadian aquaculture production may grow by 15% per year to 511,000 mt with a value of $3.1 billion by 2010. This projected growth rate is about 1% higher than the actual rate of change in production over the 1996-2000 period.

BC's Potential

The following key attributes provide a strong framework for the BC shellfish farming industry to expand and prosper:

- ☐ Vast bio-physical potential
- ☐ Large pristine coastline = clean water = high quality
- ☐ Environmental sustainability
- ☐ Available workforce, existing technology
- ☐ Access to export markets

Provincial Shellfish Projections

Key findings of the Coopers and Lybrand (1998) report indicate that:

- ☐ The shellfish industry in British Columbia has the potential to generate $100 million annually, growing from the 1995 level of $10.9 million.
- ☐ This growth would provide an additional 1000 jobs.
- ☐ In order to realize this growth, a doubling of aquatic land allocated to shellfish growing would be required (from 1750 to 3500 hectares).
- ☐ A large share of the benefits will accrue to coastal communities now facing job losses in other resource sectors.
- ☐ The culture of new shellfish species such as scallops, abalone, sea urchins, and sea cucumbers hold further promise for economic expansion.

The shellfish industry in British Columbia has the potential to generate $100 million annually, growing from the 1995 level of $10.9 million.

Coopers and Lybrand (1998) made the following conclusions on the industry's potential:

> "*On the basis of market trends, productivity increases, and the estimates of capable lands, the shellfish farming industry could contribute substantially to the provincial economy and the balance of trade with seafood. The BC shellfish farming industry has the potential to become as large or larger than the Washington State shellfish farming industry.*"

The BC shellfish farming industry has the potential to become as large or larger than the Washington State shellfish farming industry.

Canadian Aquaculture Industry Alliance Industry Survey, 2002

A recent aquaculture industry survey, conducted by Praxis Research & Consulting Inc. (2002) for the Canadian Aquaculture Industry Alliance (CAIA) indicated that future production and value depended on the regulatory regime that will be in place over the next five years, and that accurate projections could not be made unless the specifics of this regime were known.

Shellfish production on both coasts would increase significantly, possibly by 20% per year over the next five years.

However, some of the industry members that were interviewed estimated that shellfish production on both coasts would increase significantly, possibly by 20% per year over the next five years.

Office of the Commissioner for Aquaculture Development "Think Tank"

In August of 2001 the Office of the Commissioner for Aquaculture Development hosted a "Think Tank" attended by Canadian industry leaders in Merrickville, Ontario. The following forecast was made by the group and included information about both finfish and shellfish production and value.

Table 3. Projections of the OCAD National Aquaculture Think Tank August 2001. (Source: OCAD 2001)[17]

	2000		**2010**	
Culture Species:	**Tonnage x 1000mt**	**Value ($ million)**	**Tonnage x 1000mt**	**Value ($ million)**
Salmonids	84.9	$511	350	$2,100
Other Finfish	0.5	$5	50	$300
Mussels	17.3	$23	69	$93
Oysters	9.3	$14	36	$57
Clams	0.9	$4	4	$16
Other Shellfish	0.1	$0	2	$4
Subtotal	113	$557	511	$2,570
Value-Add				$500
Supplies & Service				$3,100
TOTAL				**$6,170**

The table indicates that production of established species of finfish and shellfish was projected to grow by about 300% except for clams that were projected to increase by almost 350%.

Production of shellfish species other than those produced commercially in 2000 were projected to grow rapidly but only reaching a value of $ 4 million by 2010.

> *"… it was agreed that very conservative forecasts indicate that the Canadian aquaculture industry will likely grow from $ 700 million to at least $ 3.1 billion in 2010 …."*
>
> (OCAD, August 2001, p. 2)

The Canadian aquaculture industry will likely grow from $700 million to at least $3.1 billion in 2010.

Regional Projections for Growth:

According to Ecotrust Canada (2002), the shellfish volume harvested from the Clayoquot Sound area alone is expected to triple within the next two years and a local industry of $2,000,000 per year in just this one portion of the West Coast of Vancouver Island is very attainable within the next 3-5 years.

The shellfish volume harvested from the Clayoquot Sound area alone is expected to triple within the next two years.

Status of the Shellfish Development Initiative (SDI)

As a result of the Coopers and Lybrand (1997) report, the *Shellfish Development Initiative* (SDI) was announced in November 1998. This important provincial initiative directly followed the recommendations set out in the Coopers and Lybrand report. The SDI set as its goal to double the amount of foreshore Crown land to be made available for shellfish aquaculture, providing an additional 2000 hectares to the present land under tenure.

In relation to this proposal, coastal First Nations were identified as specific target groups to benefit from the initiative. The Province's plan to expand land for shellfish aquaculture included a commitment to enter into agreements with aboriginal communities to reserve sites within their traditional territories for their exclusive future use. These sites are set-aside for ten years, during which time the First Nations can make an application for tenure.

Shellfish growers have expressed a great deal of concern at the delays that are occurring with regards to the SDI. In particular, new environmental regulations (CEAA) are now triggered with all new structures or works. The time to complete federal review of an application has increased to months, rather than days or weeks.

At the same time that growers are frustrated with the expansion and new tenure process, there is a parallel groundswell of negative public opinion about the industry and the SDI from upland owners.

At the same time that growers are frustrated with the expansion and new tenure process, there is a parallel groundswell of negative public opinion about the industry and the SDI from upland owners.

In some areas, community landowners are organizing themselves to fight any further expansion of the industry. These groups (such as the Alliance for Responsible Shellfish Farming and Friends of Cortes Island) cite the following as their main concerns:

- ❑ aesthetic considerations and potential changes in waterfront property values
- ❑ potential and perceived environmental effects of intensive shellfish culture

Potential for First Nation Communities

At a time when coastal First Nations communities are struggling with the decline of many of the resource-based industries upon which they have relied, shellfish aquaculture may offer great potential as an economic development alternative. The opportunity therefore exists for coastal First Nations to fully participate in the development of the shellfish aquaculture industry in British Columbia, thereby creating a vehicle for the sustainable economic development of their communities.

A significant number of coastal First Nations communities have already shown significant interest in the commercial potential of shellfish culture for economic development. This interest arises not only because of the potential economic returns, but also because of the many compatibilities that exist between aboriginal communities and shellfish culture:

- ❑ The harvesting of shellfish for food and cultural purposes is a longstanding practice deeply rooted in aboriginal communities. Aboriginal communities are, therefore, very familiar with shellfish resources and already have extensive experience in harvesting them. This historical relationship provides an ideal foundation for moving into commercial development.
- ❑ Shellfish culture provides an opportunity to generate economic activity that can be organized in accordance with the family and community groupings that traditionally came together to fish.
- ❑ Shellfish aquaculture is viewed by aboriginal communities as an environmentally sustainable industry which is therefore compatible with their environmental values.

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3.0 Production and Culture of Farmed Shellfish Species Overview

Table of Contents

3.1 Introduction 2
3.2 Pacific Oyster Production and Culture 3
  Potential 3
  Culture Methods 5
  Products and Processing Technologies 8
  Site Selection 8
3.3 Mussel Production and Culture 10
  Potential 10
  Culture methods 11
  Site Selection 12
3.4 Scallop Production and Aquaculture 14
  Potential 14
  Culture Techniques 15
  Site Selection 16
3.5 Manila Clam Production and Culture 19
  Potential 19
  Culture Techniques 20
  Site Selection 21
3.6 Abalone Production and Culture 23
  Potential 23
  Culture techniques 24
  Site Selection 27
3.7 Geoduck Production and Culture 29
  Potential 29
  Culture Techniques 29
  Site Selection 31
3.8 Sea Urchin Production and Culture 32
  Potential 32
  Culture Techniques 32
  Site Selection 34
  Natural vs. Artificial Diets 34
3.9 Cockle clam Production and Culture 36
  Potential 36
  Culture Techniques 36
  Site Selection 37
3.10 Kelp Production and Culture 39
  Potential 39
  Culture Techniques 40
  Site Selection 40

3.1 INTRODUCTION

Each overview is designed to give a brief synopsis of the products, culture techniques, potential and issues surrounding culture for each group.

In this section, production and culture overviews are given for 8 shellfish species and for kelp culture. Each overview is designed to give a brief synopsis of the products, culture techniques, potential and issues surrounding culture for each group.

This list is by no means a complete list of all species that may eventually be cultured in British Columbia in the future. It is limited to those species already in production, (Pacific Oysters, Mussels, Japanese Scallops and Manila Clams) and those species with the most immediate potential for commercial culture potential in the near future (Northern Abalone, Geoduck, Sea Urchins, Cockles).

Therefore, this report does not include Sea Cucumbers, Rock Scallops, European Flat Oysters, or Littleneck Clams for example.

A brief overview of kelp culture has been added, as this is highly compatible with shellfish aquaculture, utilizes many of the same site selection criteria and maybe a component of other shellfish culture production operations. For example, kelp culture maybe utilized as a means of producing feed for abalone and sea urchin culture operations.

For more information about specific culture techniques, the reader is urged to consult the BC Shellfish Growers Association *Information Resource System* which may be found at:

http://www.bcsga.ca/bcsgirs/main/sgmain.htm

3.2 PACIFIC OYSTER PRODUCTION AND CULTURE

Species: Pacific Oyster (*Crassostrea gigas*)

Culture Type: Intertidal /Deepwater

Products: Single oysters, Fresh / Frozen / Frozen Top Valve Off (TVO) Tray-grown or beach Grown
Shucking Oysters –Oyster Meats – Fresh / Frozen / Value Added

Pacific Oysters produced in British Columbia are mainly produced for fresh shucked (oyster meats) and whole (live) markets.

Potential

The species most widely cultivated in BC and the Pacific Northwest today is the Pacific Oyster. It is native to Asia, and BC stocks originated around the northern Japanese island of Hokkaido. The European flat oyster (*Ostrea edulis*) is a medium-sized oyster that was once the most widely cultured oyster in Europe and is now grown in British Columbia in small quantities.

Small amounts of Pacific oysters were first brought to BC around 1913, but most of the seed was imported from Japan beginning around 1930. These oysters became naturally established in several areas including Ladysmith Harbour, and Baynes Sound and are now bred irregularly on the South Coast. The waters of the Central coast and the North coast of BC are too cold to support successful spawning of Pacific Oysters. At present, almost all oyster seed is produced in hatcheries in the United States or on Vancouver Island.

The Pacific Oyster is the most widely cultivated shellfish species in the world, worth more than 3.4 billion (US) annually. British Columbia produces approximately 5% of North American oyster production and approximately 0.12% of Pacific Oyster global production.

Currently, a very small number of the European Flat Oyster (*Ostrea edulis*) and the Kumamoto oyster, a subspecies of the Pacific oyster have been cultured in British Columbia.

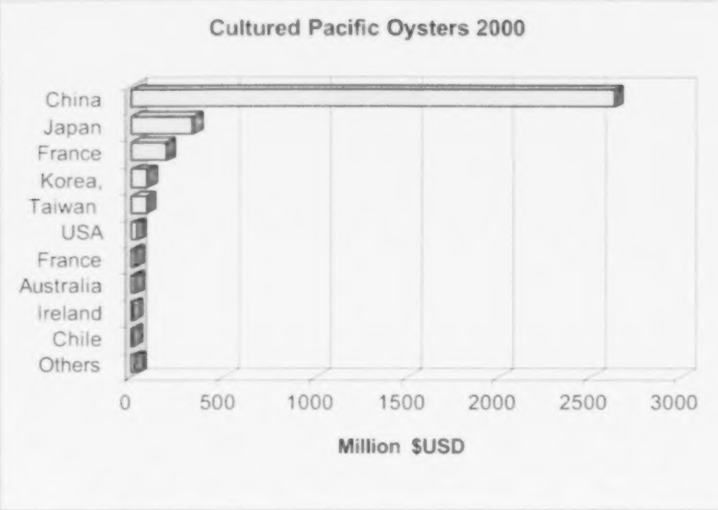


Figure 3.2.1. The top ten producing countries of Pacific oysters in 2000.

(Source: FAO FishStat 2002)

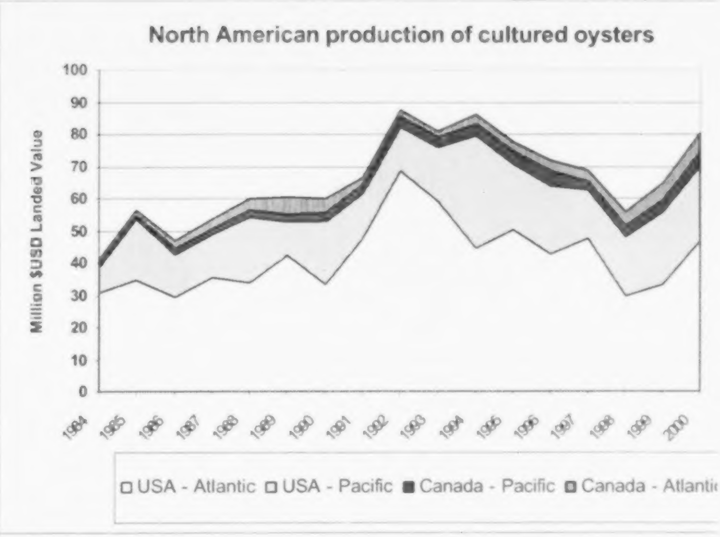


Figure 3.2.2. North American production of cultured oysters 1984-2000.

(Source: FAO FishStat 2002)

In British Columbia, oysters are generally marketed as "shuckers" and/or "in-shell". "Shuckers" are oysters produced for their meats, which are removed from the shell in federally inspected processing plants and sold by volume (typically quarts or gallons). Shucking oysters are usually between 10 and 15 cm (4 to 6 inches) in length and process recovery is between 100 to 120 meats per US gallon. Growers are paid according to meat yield, and usually receive between $15 and $17 per US gallon. Current production is approximately 128,000 gallons per year.

Oysters are generally marketed as "shuckers" and/or "in-shell".

"In-shell" oysters are produced for the single or half-shell market. They are a higher value product that is sold by the dozen in a variety of size grades ranging from 5 cm (2 inches) to greater than 15 cm (6 inches). Farmgate prices range from approximately $1.75 to more than $6.00 per dozen. A recent development now includes a proportion of the oyster production to be flash-frozen as meats, whole oysters or TVO (top valve off). Current production of single oysters is approaching 2 million dozen per year.

Culture Methods

BC shellfish growers utilize a diverse number of technologies and methods for culturing oysters. Techniques vary depending on the site, the type of product and the method preferred by the grower.

Due to unpredictable natural recruitment, oyster production is based on the purchase of oyster larvae from large, specialized shellfish hatcheries. Seed is typically acquired as microscopic larvae and is "set", a process by which a free-swimming juvenile undergoes metamorphosis into a sessile juvenile. This process known as "remote setting" is performed either on site or at a central site, onto substrates called cultch (usually old oyster shells which are known as "mother shell"). Alternatively, juvenile oyster seed is acquired as individual singles and nursed in floating upwellers "FLUPSY's" to a size of approximately 2.5 cm (1 inch), prior to transferring to final grow-out techniques. Some growers specialize in remote setting or nursery operations that sell juveniles to other farms.

Grow-out Techniques

There is a variety of shellfish aquaculture growing technologies used. Depending on the type of site three types of habitat can be utilized. They are:

- ☐ bottom culture where the species is grown on the bottom surface– for example on the beach;
- ☐ near-bottom, where the growing is done on structures constructed on the bottom and attached to it– for example inter-tidal zones; and
- ☐ off-bottom, or suspended species are grown on structures suspended in the water between the surface and the bottom--for example on long-lines, or from rafts.

Much of the development of the industry, however, is coming from deep-water or off-bottom culture where oysters remain fully submerged during grow-out.

Three brands of plastic oyster trays and one wire mesh tray, which have been developed and produced by BC farmers.

The oyster-growing industry in British Columbia has been revolutionized over the past twenty years.

Most BC production on intertidal ground relies on direct seeding of shell cultch or single oyster seed. Although higher productivity methods do exist, such as "rack and bag" culture, these are currently being used only to a limited extent. In the intertidal grow out area there is an increasing trend to culture more single (half-shell) oysters and less shucking stock. The intertidal area is also being used more for the conditioning of seed and/or mature stock grown out in deepwater culture. Grow-out times for beach product range from 2 years to more than 5 years.

Much of the development of the industry, however, is coming from deep-water or off-bottom culture where oysters remain fully submerged during grow-out. Grow-out time is usually halved with this method and 10-15 cm (4-6 inches) oysters, large enough for shucking product, can be produced in 2 growing seasons in most areas. Oysters are never grown-out on the sub-tidal bottom in deep water.

Deepwater Tray Culture

On some farms, single oysters are contained in specially designed plastic culture trays and grown for 1 to 2 years before being sold directly or placed into the intertidal zone to harden the shellstock. Although tray culture has existed in BC for decades, its use has increased dramatically in British Columbia over the last several years with approximately 4 types of plastic and wire mesh trays now being produced. Several factors have led to the recent development: increase in demand for small "half-shell" oysters; a BC produced tray culture technology; a readily available supply of large FLUPSY oyster seed.

Deepwater Tube and String Culture

The traditional use of old oyster shell (cultch) with attached seed being inserted into the strands of two strand polypropylene rope (string culture), still provides much of the mainstay for off - bottom oyster culture. Alternately, French tubes (pipes) are used to produce shucking oysters. These are 2 m ribbed PVC tubes onto which oyster larvae attach through remote setting. Use of this method is increasing as it lends itself to mechanical harvesting. In both these methods, individual strings or tubes are hung vertically from longlines or rafts for 2-3 year grow-out to a size of 10-15 cm.

Whatever the method, farmers working deep-water leases often use longlines or rafts to suspend the oysters being cultured. Longlines involve suspending a rope horizontally in the ocean from a series of floats from which culture equipment is suspended. Anchors at either end of the longline or "grids" of multiple longlines keep the longlines taut and in place within the tenure boundaries. Rafts (typically 8 m^2) are constructed from wood with wrapped Styrofoam flotation and allow for much higher density of culture per unit area.

Much of the development of the industry, however, is coming from deep-water or off-bottom culture where oysters remain fully submerged during grow-out.

The oyster-growing industry in British Columbia has been revolutionized over the past twenty years. More and more production is moving from simple sowing on beaches to deep water (off-bottom or suspended) methods of growing oysters where oysters are cultured off the bottom suspended from some form of flotation, buoy, or raft.

On the South coast many beaches with suitable substrate material where oysters have been grown, are now being converted to clam culture or clams are co-cultured with oysters. The development of off-bottom growing methods for oysters has pushed productivity and technology to new levels.

Mechanization of Culture

Where once oyster growing was more like ranching, it is now more familiar to farming and agri-business. With the trend towards increased mechanization of harvest technologies, intensive culture operations are replacing extensive methods.

Mechanization of normal culture practices cannot be expected to increase significantly in the near future. Most husbandry tasks remain labour intensive and mechanization improvements generally relate to the addition of larger work boats or in the addition of hydraulics (cranes, winches etc.). There is a trend to the development and increase of sorting/grading machinery for culturists working with large numbers of seed (i.e. FLUPSY operators and tray culturists). This development is being limited by the fact that established producers or suppliers of this kind of equipment do not exist in British Columbia. In addition, most producers have to fabricate machinery from scratch. It is anticipated that as existing producers "scale up" production, mechanization will play an increasingly important role.

Most efforts of mechanizations in oyster culture are occurring with harvest processes, as this is the most labour intensive area of culture and deals with the largest volumes of shellstock. Mechanization is being applied primarily to deep-water culture of oysters and there is a trend to the construction and use of larger hydraulic assisted workboats and equipment. Several larger producers are currently using mechanical harvesters for pipe-cultured oysters.

Products and Processing Technologies

Pacific Oysters produced in British Columbia are mainly produced for fresh shucked (oyster meats) and whole (live) markets. Current value-added processing is primarily the use of flash freezing for oyster meats and whole shell with top valve removed (TVO). It is anticipated that the production of frozen products will increase.

The development of off-bottom growing methods for oysters has pushed productivity and technology to new levels.

General trends for product types include a shift from shucking stock (processed for meats) to single oysters (live in-shell) and gradual shifts from beach culture to deepwater culture. This includes direct culture of single oysters and techniques to recover a portion of oysters that would normally go to lower value processing for shucking.

Market pressures can be expected to result in a shift to smaller shucking oysters and an increase in more consumer friendly value added products. There will also be a continued emphasis on product quality and consistency, product safety and continuity of supply.

Site Selection

Oysters are hardy and can be grown in most areas of the BC coast, although temperature is the greatest factor in determining growth. The ideal habitat or site conditions for oyster farming are usually found in bodies of water where sufficient nutrients are available through naturally-occurring food sources such as plankton, algae or other tiny naturally-occurring organisms. Ideal water temperature ranges and flows are steady and reliable, and climatic conditions, such as wind and weather, allow the seed to grow to a marketable product size.

The following tables summarizes various biophysical parameters conducive to oyster growth and survival.

Table 3.21. Summary of optimal biophysical for parameters deep water for Pacific oyster culture

Depth	5-15 m
Temperature	13-18°C
Salinity	15-32 ppt
Oxygen	>30 ppm
Productivity	phytoplankton- moderate/continuous

Table 3.2.2. Summary of optimal biophysical parameters for intertidal Pacific oyster culture

Substrate	Firm, stable bottom
Temperature	13-18°C
Salinity	15-32 ppt
Oxygen	>30 ppm
Productivity	phytoplankton- moderate/continuous

A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of oyster culture in British Columbia

Table 3.2.3. Summary of advantages and disadvantages of oyster culture

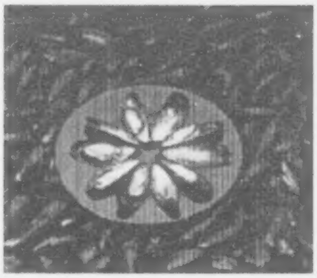
Advantages	Disadvantages
Potential for branding and value added processing techniques. Export market potential	Product is a commodity and prices are competitive, potential for oversupply in standard US markets
Established culture methods and equipment	Labour intensive but may be partially mechanized
Hardy species can handle wide range of temperature and salinity	Product is bulky and low value for weight
Established seed sources in BC and USA	Half shell markets require year round and regular service
Few if any significant disease problems in BC	Colder waters in some areas of North Coast may significantly affect growth rates
	Labour intensive but may be mechanized

3.3 MUSSEL PRODUCTION AND CULTURE

Species: Blue mussel (*Mytilus edulis*),
Mediterranean mussel (*M. galloprovincialis*)

Culture Type: Deepwater

Main Products: Whole mussels, value added products (frozen, vacuum packed)



Mussels are farmed in many areas of the world.

Potential

Mussels are farmed in many areas of the world with the most common species cultured being the blue mussel, *Mytilus edulis*. The Mediterranean mussel (*M. galloprovincialis*) is the second most cultivated mussels species. Blue mussels are the most commonly farmed shellfish in Eastern Canada. The most common native species in BC is a blue mussel called *Mytilus trossulus*, which is largely indistinguishable from the farmed Blue mussel *(M. edulis*).

Previous experiences with the native blue mussel were unsuccessful as the species does not reach marketable sizes and has thin shells which break during handling. The farming of Eastern blue and Mediterranean mussels is recent in British Columbia and many production problems remain.

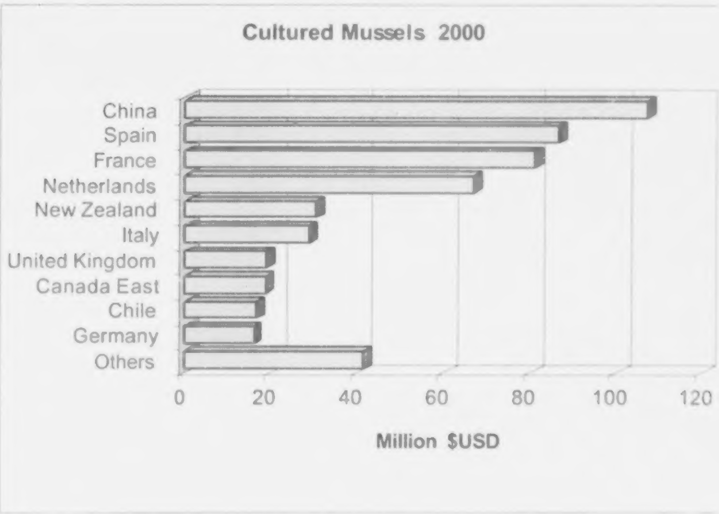


Figure 3.3.1. The top ten producing countries of cultured Mussels in 2000.

(Source: FAO FishStat 2002)

Mussels can be grown to marketable size in 12-18 months in British Columbia, and the product is typically of high quality. The blue mussel is a commodity in most of North American and previously there have been significant swings in the farmgate prices of East Coast mussels. The Mediterranean mussel is higher valued because of its better meat quality and the fact that it is in season when the blue mussel is at its poorest seasonal meat quality.

Culture methods

Seed Production

As native species of BC are not suitable for cultivation, mussel seed will need to be purchased from specialized shellfish hatcheries.

As indigenous mussel species (*Mytilus trossulus*) of British Columbia has been shown to be not suitable for cultivation, mussel production is based on the purchase of mussel spat (seed) from large, specialized shellfish hatcheries. Several settlement materials and technique have been developed and commercialized. Currently, two hatcheries in British Columbia and one hatchery in Washington Sate produce mussel seed for sale[1,2,3]

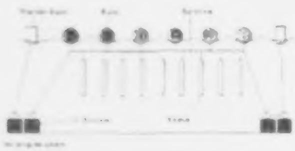
Nursery

Seed may be purchased at approximately 1mm in size or after it has been nursed in upwellers to increase the size of the animal from 2-3 mm to a size of 6-15 mm. The mussels are set on framed screens and placed in protected floating nursery systems. Once the mussel seed is hard set on the screens, they are removed from the frames and put into fine mesh bags and hung from longlines for 2 – 3 months. At this point, the juvenile or seed mussels are loaded into a continuous sock-like cotton tube (approx. 17.5 cm wide) to which they will readily attach themselves.

Grow-out Techniques

Mussels are grown entirely utilizing deep-water suspended culture methods. Once the socks are filled with seeds they are transported to empty longlines or rafts. Mussels are grown on vertical ropes known as "droppers" which hang from the horizontal rope for a length of 4 m or in "New Zealand" style continuous socks. The droppers are placed a minimum of 0.5 m

Mussel longline schematic



continuous socks. The droppers are placed a minimum of 0.5 m apart and have at least 4 m of free space from the bottom. The sock-like tubes are mesh which cover a fuzzy rope of polyethylene. The mussels grow and attach to the ropes using their byssal threads and the cotton slowly disintegrates and falls away. Most of the sleeving (seeding) is done in the fall. The density at which mussels can be cultured on longlines could be about 300 per meter, but it depends on food availability, which varies from site to site. It usually takes 1 to 1 ½ years after socking for a mussel to reach a size of 2 to 3 inches.

The biggest issue for mussel growers is typically predation by diving ducks (scoters, scaups and golden-eyes) and a scaring (human presence) program is generally used for longline culture or rafts. Moreover, the culture operations can be surrounded with predator exclusion nets.

In British Columbia some growers are experimenting with growing small sections of mussel sock in oyster grow-out trays. This prevents bird predation, but adds significant capital cost.

Harvesting

At harvest, the mussels are stripped from the ropes and are processed by cleaning, debyssed (removal of byssal threads) and graded. This is usually automated and large volumes may be harvested in short periods of time.

Site Selection

Blue mussels are abundant, bivalve molluscs of the intertidal and shallow, subtidal zone. Although mussels can be grown in full oceanic conditions, embayments are generally more productive because they have higher nutrient levels, higher water temperatures and offer a more sheltered location.

The Mediterranean mussel requires warmer temperatures than the Blue mussel but lower water temperatures may result in significantly longer growth. When grown in oceanic conditions in BC, the Mediterranean mussel has also experienced periods of high spring mortality after reaching harvest sizes. Although the specific cause is not yet known, it is believed to be environmental. The Blue mussel has a very high capacity for withstanding temperature and salinity ranges.

The following table summarizes various biophysical parameters conducive to mussel growth and survival.

Table 3.3.1. Summary of optimal biophysical for parameters deep water for Mussel oyster culture

	Blue Mussel	Mediterranean Mussel
Depth	5-15 m	5-15 m
Temperature	8-18°C	10- 20
Salinity	15-32 ppt	15-32 ppt
Oxygen	>30 ppm	>30 ppm
Productivity	phytoplankton-moderate/continuous	phytoplankton-moderate/continuous

A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of oyster culture in British Columbia

Table 3.3.2. Summary of advantages and disadvantages of mussel culture

Advantages	**Disadvantages**
Potential for value added processing techniques. Export market potential	Product is a commodity and prices are competitive
Popular menu item, strong markets	Mediterranean mussels require warmer water and subject to high mortality
Blue mussels suitable for cold waters	Seed supply is not well established, may require local hatchery development
Established culture methods and equipment, Mussel culture is easily mechanized	Bird predation and avoidance techniques significant factor
Hardy species can handle wide range of temperature and salinity	

3.4 SCALLOP PRODUCTION AND AQUACULTURE

Species: Japanese (Pacific) Scallop (*Patinopecten yessoensis*)

Culture Type: Intertidal /Deepwater

Main Products: Whole Scallops (40 –50mm shell length)
Scallop adductor muscle (shucked) - (70 -120 mm shell length)

Potential

Moderate levels of cultured scallops have been harvested and sold in British Columbia since 1995. In 1999 scallop production reached 30 t with a landed value or $200,000 or $6.60/kg.

The farming of scallops is one of the largest producing aquaculture activities in the world, both in terms of volume and value of production. The Department of Fisheries and Ocean and the BC Province introduced the Japanese scallop (*Patinopecten yessoensis*) from Japan in the mid 1980's because of its fast growth rates, established culture methods and high value.

British Columbia has one other species of scallop, the Purple hinge rock scallop (*Crassadoma gigantea*) that has commercial potential for culture. There are three other species that are of sufficient size to make them attractive to the market. Of the following species, the Pink scallop (*Chlamys rubida*), the Spiny scallop (*C. hastata*), and the Weathervane scallop (*Patinopecten caurinus*), fisheries exist only for the Pink and Spiny scallops. The Purple-hinged rock scallop is not as valuable or attractive for culture and only preliminary investigatory studies have been undertaken.

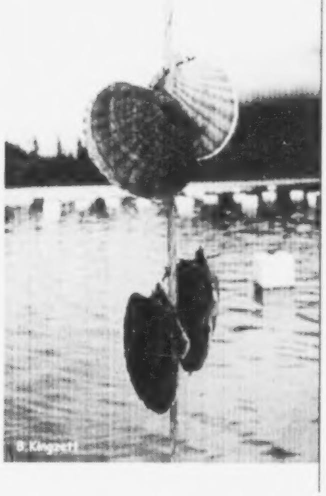
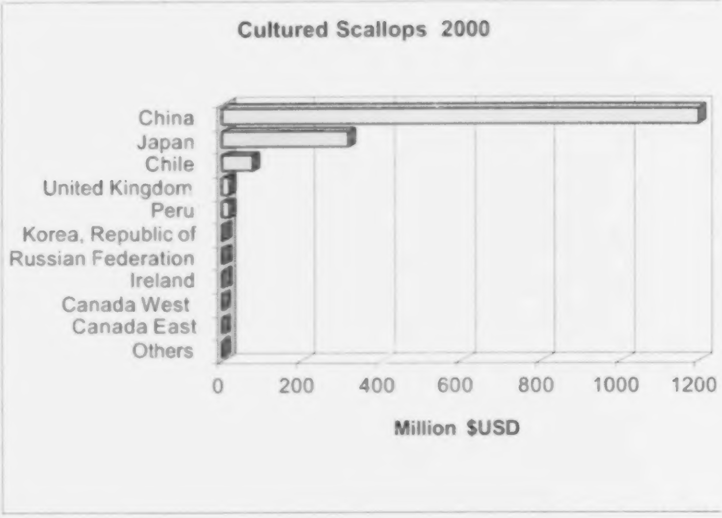


Figure 1. The top ten producing countries of Scallops in 2000.

(Source: FAO FishStat 2002)



Culture Techniques

Seed Production

Seed scallops have a relatively low tolerance for temperature and salinity fluctuations but require optimal plankton availability.

Seed production of scallops in BC is based on hatchery production. Currently only one hatchery[4] regularly produces Japanese scallop juveniles (spat) for sale to growers. Collection of wild scallop seed for rock scallops has never been a viable option for commercial culture due to the amount of juveniles caught. A shellfish hatchery in Alaska is currently producing rock scallop seed for sale.

Intermediate Grow-out

When juvenile scallops are 5-10 mm in diameter they are ready for transfer to intermediate grow-out. At this stage they are about one year old. This is usually done in fine mesh lantern nets or pearl nets. These are suspended on longlines placed deep enough in the water to be below the action of surface waves.

Longlines consist of lengths of polythene rope anchored firmly at each end. They have floats and ballast weights to keep the line suspended just far enough below the surface to avoid the wave action. Japanese scallops cannot withstand wave action while in culture. Fast growing juveniles will need to be checked regularly and thinned into larger mesh nets as they grow. Nets must be checked regularly and cleaned of fouling organisms.

With scallops, the grow-out options include hanging from lines, bottom seeding, using the cages or lantern nets. These cages, in square or round shapes, are usually used in shallow water grow-out sites and are like mini-apartment buildings with about 10-20 levels. Scallops are loaded into the different levels and the nets are suspended in mid-water as before. As the scallops grow they are thinned into larger mesh nets. The mesh should be just small enough to prevent the escape of scallops, and large enough to maximize water exchange.

An alternative is to pass plastic toggles through small holes drilled in the scallop shell and suspend them from the longline, known as "ear-hanging". This can be done when the scallops are small; approximately 30 mm in diameter, but the operation is delicate. In Japan specially develop machines are used to mechanize this process.

There are advantages and disadvantages to each method. The lantern net system is both labour and capital intensive. They can also be graded each time they are thinned, thus it is easier to harvest uniform sized animals. Ear-hanging techniques lend themselves to automation and once suspended, the scallops do not need to be handled until harvest. A disadvantage though is that the shells may become heavily overgrown, and require cleaning if the scallops are to be sold alive.

The fourth option is for the scallops to be scattered on the bottom for harvest by conventional fishing techniques, or by divers. In this case, growth to market size may take longer, and mortality is higher, particularly among small scallops. This is not seen as a viable option in BC at this time because of sea star predation and conflicts with fisheries habitat arising from dredging operations.

Growth varies from site to site, and there is also much variation in growth rates between individual scallops. Nevertheless, scallops in suspended culture have been grown to marketable size in 18 months to 2 years for meat production and within one year for whole shell products.

Site Selection

Sites allocated for scallop farming must reach certain criteria in order to provide the optimum conditions for growth and survival. Scallops can only be cultured at deep depths. There are three basic characteristics to be considered when selecting a site for scallop culture:

- maintenance of low moderate water temperatures (7-13°C, <15 °C);
- sustaining high water column salinity (>28 ppt); and
- minimizing movement and motion of the culture apparatus (if suspension methods are used).

Japanese scallops are a cold-water species, preferring water temperatures ranging between 7-10°C. Growth slows when water temperatures exceed 12.5°C and mortalities may occur at temperatures exceeding 16°C. Salinities between 28-31 parts per thousand (ppt) are tolerated, though 30-31 ppt are optimal. Scallops do well in areas with good (but not excessive circulation). These currents will supply an adequate level of planktonic food and water exchange for respiration and excretion. The following table summarizes various biophysical parameters conducive to scallop growth and survival.

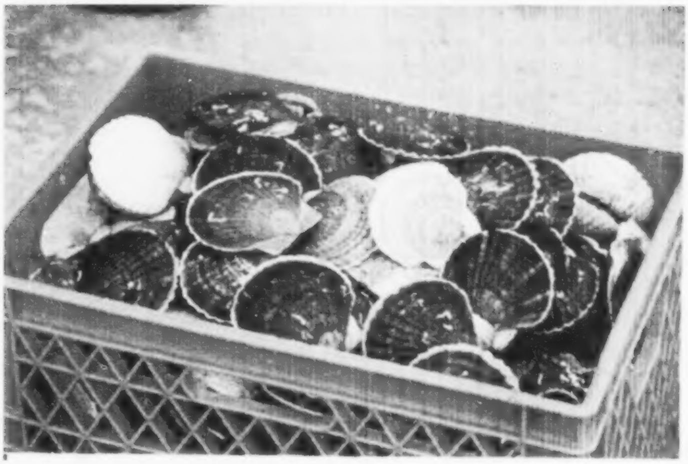
Table 3.3.1. Summary of optimal biophysical parameters for scallop culture

Depth	10-50 m
Temperature	7-13°C <16 °C
Salinity	28-32 ppt
Oxygen	>30 ppm
Productivity	phytoplankton- moderate/continuous

A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of oyster culture in British Columbia

Table 3.3.2. Summary of advantages and disadvantages of scallop culture

Advantages	Disadvantages
High Value product, in demand	Scallops are fastidious and may suffer high mortality if conditions are not correct. Require specific temperature, exposure and salinity regimes.
Established culture methods	Largely capital intensive, materials and equipment may be imported from Asia
Well suited to cold oceanic water of Central and North Coast	Hatchery seed only and at present only one established source of seed
	Scallops require a long time to depurate PSP (can be >6 mos). Affects potential for whole market
	Labour intensive
	Disease problems have been encountered at some sites (reasons unknown)
	Affected by bio-fouling



3.5 MANILA CLAM PRODUCTION AND CULTURE

T DeJager

Species: Manila clams (*Venerupis philippinarum*)

Culture Type: Intertidal

Main Products: Fresh "Steamer clams"

Potential

The species that now dominates clam farming in BC is the Manila clam (*Tapes philippinarum*). Like the Pacific oyster, Manila clams are not indigenous to this area. It 'hitch-hiked' here with Pacific Oyster seed brought in from Japan in the 1930's. The first specimens were found in Ladysmith Harbour in 1936. It lives along much of the BC coast as far north as the Bella Bella region.

Clam farming is a relatively new venture in BC. As market demand and value of Manila clams increased in the mid 1980s, oyster growers in the province became increasingly interested in culturing Manila clams commercially. Techniques had been worked out in Washington State, and by the mid 1980s the Washington clam culture industry had become well established. The first permitted clam farms in BC were established on existing shellfish culture leases in 1988. The licensing of clam farming did not become official until 1991 when the provincial government and the Department of Fisheries and Oceans signed the Canada-British Columbia Letter of Understanding to promote "the development of a viable clam culture industry in BC."

Manila clams are generally marketed as "steamer" clams.

The market demand for small "steamer" clams is very good and the prices are high. The production of Manila clams has increased continually with production by 1999 reaching a volume of 900 metric tons (mt) valued at $3.8 million farmgate and $6.6 million wholesale value (BC Ministry of Agriculture Food and Fisheries, 2001). Manila clams are one of the most cultured shellfish species in the world worth more than 2 billion US. Canada produces approximately 0.14% of world value.

The sale price of cultured Manila clam is fairly stable in British Columbia at about $5.00/kg at the farmgate price.

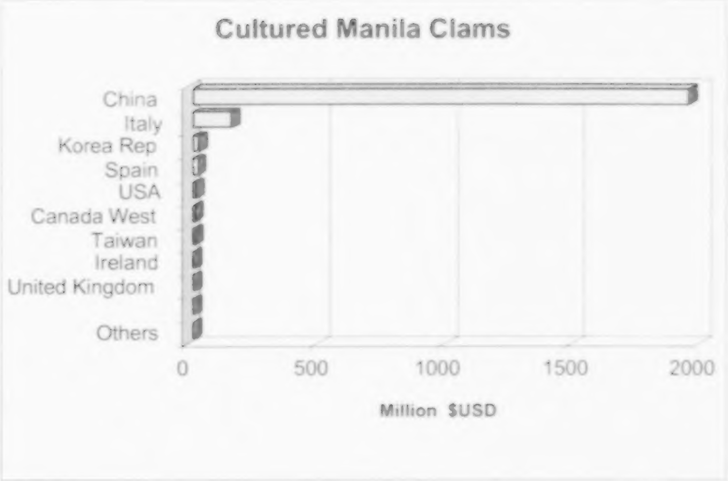


Figure 3.5.1. The top ten producing countries of Manila clams in 2000.

(Source: FAO FishStat 2002)

Culture Techniques

The Manila clam occupies an area higher in the intertidal zone and does not burrow as deeply as native species such as Butter clams (*Saxidomus giganteus*) and Littleneck clams (*Protothaca staminea*). It has managed to co-exist well with other species. While Manila clams are the cultured species, some natural recruitment of the less valuable Littleneck clams inevitably occurs and some of these are often harvested along with the Manila clam.

Seed Production

Natural recruitment of Manila clam seed in British Columbia is unreliable and unpredictable due to normal annual fluctuations in water temperature, weather and wind, while currents in the present northern limits of the clam's distribution has becomes more sporadic. Manila clam production is based on the purchase of spat (seed) from specialized shellfish hatcheries. Hatcheries will often undertake the first stage of nursery rearing in indoor upwellers, which can be used to raise seed from the time they have set (approx. 0.2mm in size) up to the specific sizes growers can purchase (e.g. 2-3 mm, 3-4 mm, 4-6 mm, 6-9 mm).

Grow-out Techniques

All clams are grown intertidally on beaches with specific substrate characteristics. Techniques for growing clams off-bottom have not been established. Prior to seeding the beach with clams, the area is prepared for planting, by digging out any existing clam populations. This aerates the substrate and reduces competition from wild clams. Plots for clam culture may require substrate enhancement, measures to minimize storm and wave damage and predator control. Typically, beaches must be cleared and prepared for planting and those areas may be fenced or defined. Improvement for silted or muddy beaches may mean gravelling, whereas other sites may involve debris and rock removal.

Seeding clams into the plots is usually done in the spring. Seed is generally planted at the 5-8 mm size at a density of 200 to 600 per square meter. Losses from 6-9 mm seed through harvest are usually calculated to be 40-50% or more.

After seeding, plots are protected from predators by overlaying them with a plastic mesh car cover, which is strong and lightweight with a mesh size of approximately 5/8"x3/4". It provides protection for the clams from their main predators: scoter ducks, starfish, moon snails and crabs. The netting is often put out in a double layer to make it more durable. The periphery is threaded (woven) with a lead line (0.25-1.0 lb/fathom) that is secured to the mesh with cable ties (zap straps). This firms up the edges of the mesh so it can be handled easily. Rocks and re-bar pins can be used to secure the netting in place. The netting laid out in uniform plots also provides a means of controlling and managing production.

Depending on site characteristics, clams may take from 2 to 4 years to reach marketable size. At harvest time, the netting is removed and the clams are dug out of the substrate by hand using a clam rake.

Site Selection

The wild stock Manila clam ranges throughout the southern part of the Strait of Georgia, along the West coast of Vancouver Island and in the Central coast, to approximately the Heiltsuk and Kitasoo Regions. Since the introduction of hatchery produced seed, the Manila clam has been introduced in various bays throughout much of British Columbia, but colder water in the north often precludes spawning and natural distribution. Manila clams are normally distributed between the 1.5-2.5 m tide height, in substrates composed of a mixture of sand, shell fragments, small gravel, and mud. The following table summarizes various biophysical parameters conducive to Manila clam growth and survival.

Table 1. Summary of optimal biophysical parameters for Manila clam culture

Substrate	shell/gravel/sand/mud
Tide Height	1.5-2.5 m
Temperature	>13°C for 6 months
Salinity	24-28 ppt
Exposure	protected from wave action
Productivity	phytoplankton- moderate/continuous

A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of oyster culture in British Columbia

Table 2. Summary of advantages and disadvantages of Manila clam culture

Advantages	Disadvantages
Strong Market for Fresh product	Requires specific types of beaches
Established culture methods Little capital or mechanization required for culture	Much of central and north coast is too cold for natural spawning or recruitment
Hatchery seed readily available	Wild populations not established in Central/North Coast/Haida Gwaii, cultured populations not tested
Technology (netting) readily available	Subject to winter kill from freezing temperatures
	Labour intensive harvesting

3.6 ABALONE PRODUCTION AND CULTURE

Species: Northern "Pinto" Abalone (*Haliotis kamtschatkana*)

Culture Type: Intertidal /Deepwater

Products: Whole abalone, Fresh / Frozen/ Value Added "in shell"
Abalone steaks, Fresh / Frozen

Potential

The Northern Abalone is a native marine gastropod whose historical habitat ranges from southern Alaska to northern California.

Abalone has been harvested for thousands of years, and historically made a significant contribution to the West coast First Nations, providing value for food, social and ceremonial use. The Northern "Pinto" Abalone is an indigenous gastropod which is the common species caught and used for cultivation trials in British Columbia.

Abalone is found naturally in almost all parts of the world. In British Columbia this species was once widely, but very irregularly distributed in intertidal and subtidal habitats throughout coastal waters. As a result of over-harvesting since the 1970s, the fishery was closed in 1990 for conservation purposes to allow for the recovery of abalone stocks.

As a result of over-harvesting since the 1970s, populations have been reduced and the abalone is now a "threatened" species.

The world production of cultured abalone has grown rapidly to 7,165 metric tonnes (mt) in 1999 with an additional shortfall in supply of 7,000 mt projected.[5] Recent prices for some abalone products have included US$ 49 per kilogram for live abalone in the shell, US$ 66 per kilogram for fresh, processed abalone, US$ 45 per kilogram for frozen abalone and US$ 80 per kilogram for canned abalone. The value of cultivated abalone is approximately US$ 250 million. China is the largest producer as far as cultivation is concerned, with 3,500 mt per annum.

Abalone is considered to have pearl production capabilities and is presently being cultivated for the production of pearls and meat. Abalone pearl culture is a new industry that is still in its infancy. Highly skilled techniques are required for the consistent production of valuable pearls.

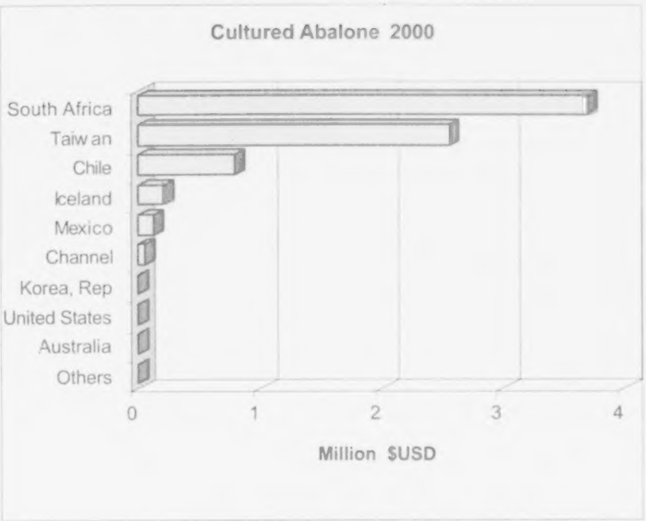


Figure 3.6.1. The top ten producing countries of Abalone on 2000.

(Source: FAO FishStat 2002)

Culture techniques

Seed Production

Hatchery technology to produce abalone seed is available from national and international experience.

The population of wild northern abalone has been severely compromised and, as a result, wild abalone seed is poor and somewhat limited in BC. To maintain a sustainable fishery, producing ripe abalone by conditioning in adult animals in hatchery is preferable. Moreover, this allows production of seed throughout the year.

Currently, each of the six pilot projects initiated under the Fisheries and Oceans Canada abalone restocking program are investing in hatchery technology to produce abalone seed. The hatcheries are expected to produce a number of abalone seed and eventually adult abalone.

Increasing the survival rate is achieved by growing the seed to 2 cm at the hatchery stage.

There are two different methods that can be used during larval rearing: static culture and flow-through, as in the case of commercial oyster hatcheries. In the static method, the larvae are reared in very large tanks or containers (5-20 cubic meters) without a continuous inflow of seawater. The water in each container is changed periodically. Northern abalone seed stock reach a shell length of 10-15 mm in 4-5 months at which time they may be transferred from the hatchery to a nursery to begin the process of grow-out to market size. Smaller juveniles (5-8 mm) should be sorted and separated from the large (13-15 mm) animals before they are reared in the nursery. This is to prevent stunting the growth of the smaller ones.

Nursery

Towards the end of larval development, the larvae sink to the bottom of the container and begin looking for a suitable surface for settlement. The larvae are transferred to the tanks used for settlement, which contain vertical PVC sheeting covered with a film of diatoms or other algae. Settlement and metamorphosis occur typically within one to three days after the larvae are introduced into the tank.

The newly settled abalone juveniles begin feeding on bacteria and diatoms that naturally occur on the surfaces of the settlement plates and tank walls.[6] Diatom growth is stimulated on the plates within long, aerated tanks, by adding nutrients to the water as needed, and ensuring long exposure to sunlight either outdoors or in greenhouses. Survival may only be 5-20% through settlement and nursery phases.

In British Columbia the over-wintering of juveniles is required to reach the minimum size for planting. Juvenile abalone of 5-6 mm is further enhanced in the nursery until juveniles reach 1.0-1.5 cm in size. Once juvenile abalone have reached approximately 1.5 cm, they can be transferred out of the nursery facility.

Intermediate culture, as well as complete grow-out can be accomplished in land and sea enclosures.

Intermediate Culture/ Grow-out Techniques

When juvenile abalone are 1.5-2.0 cm they are ready for transfer to grow-out. The main cultivation techniques for growing abalone consist of land or sea enclosures, depending on the site and the objectives of cultivation include the following:

Land-based Systems

A typical land-based facility consists of a large rearing room, which uses raceway systems to culture abalone after growth in the nursery. The building provides a dark environment and protects the animals from dying due to desiccation, and allows year round product of marketable abalone. The raceways have a water depth of 1.5 to 2 cm (just covering the abalone) and are usually 2 m long, although they can be of any length or configuration.

The water exchange rate is critical because it must be sufficient to encourage feeding behaviour, maintain dissolved oxygen levels, and cause wastes to be transferred to the outlet, but not so fast as to wash away the feed. Stocking density and feed type are important factors when considering the use of this culture system. In general, higher stocking densities in land-based systems, with most of the tank floor area covered by abalone, encourage a more uniform distribution of the animals.

While this system allows for the isolation of abalone from natural-environment predators and competitors, the animals become dependent upon mechanical water- and air-delivery systems that maintain the environment. Furthermore, this system requires high start-up capitalization costs, and the large volume of water and air pumped through the system create expensive utility bills. This type of aquaculture will also require a lot of pumps, tanks, pipes and other expensive equipment.

Ocean-based Systems

Barrel or cage culture of abalone offers a low capital cost, although high maintenance cost option for farmers. The barrels or cages can be hung from longlines supported by buoys or attached to rafts, while large cages can be placed on the ocean floor if precautions are taken to prevent predation from crabs and sea stars. Supplying feed to submerged cages has been simplified by the development of surface feeding systems. A 200 litre barrel can hold approximately 400 market-size abalone, and cages can be designed to house larger quantities of animals.[7]

Cages must be made of a material that is harmless to marine life, since abalone are very sensitive to heavy metals and anti-fouling chemicals. This requirement has a negative impact on ocean rearing because of biofouling of the cage structure and netting. Biofouling can greatly increase the maintenance costs of production systems and can directly smother the abalone by covering the respiratory pores.

Food

Abalone can be fed brown, green and red agal species, among these, tender leaves of brown algae are specially preferred. *Larminaria japonic*a, *Undaria pinnatifida*, *Ulva lactuca*, *Gracilaria tenuistipitata* and *Ecklonia kurome* are usually served as the main foods for abalone. When these algae are not available in summer, frozen algae can be used as substitute. While the favorite growth season of most brown alga species are during winter, and the abalone grow better during late spring and late fall, it is always short of fresh alga when abalone are growing luxuriantly. How to provide abalones with fresh alga during this period is a research area yet to be solved. Use of artificial diets like pellets can be a potential solution.

Rearing Time Period: The rearing period required to reach the commercial size has a close relationship with the initial size and quality of seeds, conditions of the sea area, diets and management. After 3-4 years in grow-out systems, abalone can grow to reach 8 cm, a preferred market size.

Site Selection

The selection of an appropriate site for land-based, as well as ocean-based culture of any abalone species is vital to the long term success of the operation. Sites for abalone aquaculture require easy access to seawater of high quality. Specifically, abalone have poor tolerance to the presence of ammonia or nitrite, high or low pH, and low or super-saturation of dissolved oxygen.[89]

Typically, abalone favours areas containing rocky substrates, clean water, high salinity, fast water flow raters, and optimal macroaglae resources.

The siting of the cages in ocean-based systems is also important because tides, winds, waves and storms can make it uncomfortable to work and can even affect the culture animals. A balance must be sought between having good water flow for the animals and not having too much disturbance so the food will remain available for the abalone.

The Northern abalone has a wide habitat tolerance with a good portion of coastal British Columbia falling within its historical range. In their natural habitat, abalone favor areas containing rocky substrates, clean water, high salinity, fast water flow rates and optimal macroalgae resources. Abalone are distributed to depths of 20 m, with adults normally inhabiting depths of less than 10 meters. The following table summarizes various biophysical parameters conducive to Northern abalone growth and survival.

Table 1. Summary of optimal biophysical parameters for Northern Abalone

Substrate	rock/boulder reefs
Depth	optimal 8-12 m
Temperature	1.5 - 14°C
Salinity	38-34 ppt
Oxygen	>3-4 ppm
Associated fauna/flora	urchin, macro kelps

A complete species evaluation summary is presented in Section 11. The following table provides the general advantages and disadvantages of abalone culture in British Columbia

Table 2. Summary of advantages and disadvantages of Abalone culture

Advantages	Disadvantages
Indigenous to BC, common throughout Central and North Coast	Efficient culture techniques not yet established
Very high market value and declining world fisheries	Seed availability unknown – no commercial production at this time –pilot scale only
Very high market value and declining world fisheries	Profitability not known
	Slow Growth rate
	Disease issues

3.7 GEODUCK PRODUCTION AND CULTURE

Species: Geoduck clam (*Panope abrupta; P. generosa*)

Culture Type: Subtidal bottom. Low intertidal

Main Products: Live and processed fresh

Potential

The geoduck clam (*Panope abrupta; P. generosa*) is a native marine bivalve, the largest burrowing clam species living on the BC coast. Geoduck clams are found throughout coastal British Columbia from the intertidal zone to depths of at least 110 metres. Geoduck aquaculture is still in its early stages of development in BC, but has a strong potential because of the demand for live and processed geoduck siphons and body meats in Asian markets.

Culture Techniques

Grow-out Techniques

Some studies and experimental trials have been done and a number of companies are incorporating commercial geoduck culture, but currently there are no specific descriptions of geoduck grow-out techniques. Culture techniques are being developed in British Columbia and Washington State but at present, no farms have established full production cycles or demonstrated financial success. This is primarily due to the long time frame required to achieve harvest stocks and uncertainties around production techniques.

Seed Production

Due to unpredictable natural recruitment, existing enhancement programs have to rely upon hatchery-produced seed. Hatchery technology for the geoduck has been developed and commercialized by a number of hatcheries.[10,11,12,13]. Seed is grown to 3-6 mm in the hatchery before transfer to a nursery for further out-growing.

Survival during the nursery and grow-out phases increases with the size of the animal. Various nursery systems have been developed in order to raise hatchery-produced seed from 3-6 mm size to an approximate size of 18 mm, which is considered optimal for grow-out:

- In the primary nursery component a FLoating UPwelling SYstem (FLUPSY) in which a pump maintains the water flow of this nursery system, bringing food (naturally occurring algae) to the shellfish and carries away waste, permitting seed to be grown in 2 -4 months under optimal conditions.
- In the secondary nursery component seed is over-wintered in floating and benthic tables, which makes use of naturally occurring algae and netting protection (from 6-20 mm) for 9-11 months.
- Land-based concrete raceways filled with sand

Seeding

Once they reach a size between 12-20 mm, seed is ready to be planted into the marine substrate where they will grow to market size. Seed is then mechanically planted and reared for 5-7 years, until it reaches an end market weight of 0.7 – 1.0 kg in the grow out component. Newly seeded areas are protected with nets or are planted in PVC tubes covered with net.

Harvest

Currently, harvest is undertaken by the use of underwater SCUBA or Hooka Gear, with the divers using pressurized water jets, referred to as a stinger, which loosens the substrate around the clams and allows them to be extracted from the sediment live. Only a certain percentage of geoducks have the exposed tip of a siphon visible or a dimple left in the sand from a retracted siphon, allowing a diver to find the animals for harvest. It could take up to two years of repeated harvesting attempts in order to remove all of the geoducks present on a site.

Site Selection

Geoducks are normally distributed at depths ranging from 3–20 m in coastal beds with substrates consisting of a sand, silt, gravel, and shell mix. The following table summarizes various biophysical parameters conducive to geoduck growth and survival.

Table3.7.1. Summary of optimal biophysical parameters for Geoduck culture

Substrate	mud/sand/pea gravel
Depth	Low intertidal -20 m
Temperature	8-18 degrees Celsius
Salinity	26-31 ppt
Current	<1.5 kt
Productivity	15-200 (mg/L)

A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of Geoduck culture in British Columbia

Table 3.7.2. Summary of advantages and disadvantages of Geoduck culture

Advantages	Disadvantages
Highest value clam with strong export market potential	Efficient culture techniques not yet established
Indigenous to BC found throughout coast	Long time to market maturity 4 – 7 yrs
	Profitability not proven
	High cost of seed
	High labour cost involved in SCUBA harvest
	If significant production occurs prices can be expected to drop

3.8 SEA URCHIN PRODUCTION AND CULTURE

Species: Green Sea Urchin (*Strongylocentrotus drobachiensis*),
Red Sea Urchin (*S. franciscanus*)

Culture Type: Tank. Raceway (on land or floating), extensive and reseeding projects

Main Products: Roe

Potential

In Japan, sea urchin roe is considered a delicacy and good quality products can fetch high prices.

Historically, red and green sea urchins in BC have been harvested for food, social and ceremonial purposes by the First Nations people. Sea urchins are harvested world-wide, with the majority destined for the Japanese fresh fish markets. Japan is the world's largest consumer of sea urchin roe, or reproductive organs, importing approximately 6300 tonnes worth $US243 million in 1996[14]. The red sea urchin has not received as much attention as green sea urchin culture due to the lower market price of red sea urchin roe.

Development of sea urchin culture (Echinoculture) began in the early 1990s as demanding markets, like that of Japan, created a collapse for both their local fisheries and other supplying fisheries.

Sea urchin culture is on the verge of stepping up from developmental/pilot production to commercial scale operation and is being targeted for hatchery production, re-seeding operations of commercial beds and future roe enhancement operations. The benefits of such an aquaculture venture includes the following:

- Attract a consistent customer through stability of supply.
- Receive higher prices for a higher % roe content.
- Allow harvesting at a more favourable time of year in terms of weather conditions.

Culture Techniques

Hatchery

Currently, Island Scallops Ltd. is the only producer of green sea urchin seed in British Columbia. Island Scallops Ltd. is currently able to produce millions of seed urchins and work is being done to streamline the grow-out process.

Grow-out

Grow-out methods are still experimental, despite the fact that sea urchins have been cultured in Japan since 1979 (Hatcher and Hatcher, 1997). Land- based and ocean based contained culture are the most intensive methods of grow-out, requiring maintenance of the urchin stock. Artificial diets have been designed and are manufactured on the East coast of Canada, however kelp is only available as sea urchin feed on the West coast. The methods for cultivating sea urchins include the following:

By holding and feeding sea urchins a maintenance diet and harvesting when market conditions are optimum, a premium price may be obtained.

- **Intensive Cultivation:** Sea urchins are candidate species for intensive cultivation. The main cultivation concepts for sea urchins consist of land or sea based enclosures, which meet the urchins' biological requirements while facilitating routine maintenance tasks such as feeding and removal of faecal matter. Land-based facilities could produce high quality urchin gonads at least twice a year and coordinating the availability of a high quality product with market demand (Hooper *et al.*, 1996; Cuthbert *et al.*, 1995). Such aquaculture techniques would maximize profit and reduce harvest pressure on natural populations (Hagen, 2001).

  Design options for rearing units include tanks or cages equipped with habitat modules or internal subdivisions, shallow stackable trays or raceway tanks and mini-modules. A successful industrial design based on either option is the key to enabling intensive urchin aquaculture to achieve its full potential.

- **Ocean ranching:** This method involves the out-planting of hatchery raised juvenile urchins with the intention of harvesting the populations after allowing the animals to grow to a marketable size by grazing on naturally occurring food sources. In the sea they can also be raised in clam/oyster trays.
- **Value Adding Wild Caught Urchins:** Gonad (roe) enhancement involves the holding of wild urchins with the goal of enhancing the quality of the gonad to achieve a higher market price. For enhancement of

roe content, the sea urchins can be held and fed in a land-based commercial facility. Design options for sea urchin enhancement include plastic raceway tanks supplied by a flow through system or with filtered sea water from a recirculation system, which provide optimum water flow around the sea urchins to allow for gas exchanges and easy removal of solid wastes. Sufficient surface area to which the sea urchins can attach themselves is also essential. The gonad quality and quantity of an urchin is highly dependent on water temperature and water quality.

Site Selection

Green urchins are found in areas where spring temperatures do not exceed 6-8°C because the larvae are intolerant of warmer water. Green urchins can tolerate temperatures between -1°C to 20°C. It has been found that gonad mass and quality are higher in warmer water. The following table summarizes various biophysical parameters conducive to sea urchin growth and survival. In culture, green sea urchins may be raised in tanks or land based or floating raceways.

Table 3.8.1. Summary of optimal biophysical parameters for extensive sea urchin culture

Substrate	rocky bottom/kelp beds
Tide Height	intertidal to 50 m
Temperature	9 to 20°C
Salinity	>30 ppt; optimal 28-35 ppt
Oxygen	6 ppm at 80% saturation
Water Exchange	Rapid for high oxygenation
Exposure	Below surf zone

Natural vs. Artificial Diets

Much of the current research is focused in developing diets to optimize enhancement of roe quality and yield. Best roe quality and yield is associated with brown algae, including the finger kelp, *Laminaria digitata, Dictyosiphin, Petalonia, Pilayella* (Cuthbert *et al.*, 1995). However, there are only limited stocks of these seaweeds and devising other feed sources is essential.

Prepared feeds significantly outperform kelp in terms of both juvenile somatic growth and adult roe enhancement (Pearce, DFO 2002, pers. comm.). High gonad growth rates are easy to achieve with almost any artificial diet, but quality is much more difficult. A commercial sea urchin operation is going to have to rely on prepared foods. There are too many logistical problem associated with feeding algae (e.g. biomass required, seasonal production of algae, storage of algae). Kelp may be used as a finishing diet to optimize roe flavour.

A complete species evaluation summary is presented in Section 11. The following table provides general advantages and disadvantages of oyster culture in British Columbia

Table 3.8.2. Summary of advantages and disadvantages of sea urchin culture

Advantages	Disadvantages
Indigenous to BC, common throughout Central and North Coast	Seed availability unknown – no commercial production at this time
High value roe product	High capital costs for tank/raceway based culture – power requirements for water pumping
Fast Growth rate, fast turn-over in finishing operations	Culture profitability and business models not established
Culture technologies available	Costs and production of artificial diets

The current status of the sea urchin fishery and the world-wide need for a reliable sea urchin culture system has led researchers to a consensus of specific priorities[15]:

- ☐ Develop a cost-effective artificial diet able to promote not only good growth but also an acceptable roe colour and taste.
- ☐ Establish quality standards to assess gonad colour, texture, and flavour.
- ☐ Determine the nutritional requirements needed to optimize sea urchin gonad growth and whole-animal growth.
- ☐ Determine the optimal conditions for the hatchery production of sea urchin larvae and seed as well as the optimal physicochemical parameters for the production of out-of-season high quality gonads.
- ☐ Determine the most cost-effective grow-out system whether it be land-based or sea-based.
- ☐ Determine the risk of disease outbreaks in any of the above activities.

3.9 COCKLE CLAM PRODUCTION AND CULTURE

Species: Heart Cockle (*Clinocardium nuttallii*)

Culture Type: Intertidal

Main Products: Live

Potential

The heart cockle (*Clinocardium nuttallii)* is an indigenous species to British Columbia with importance to traditional First Nation harvesting, although commercial harvest has been minimal. However, the use of this species is common in Europe and may have some appeal to the Asian market place if this species can be provided through aquaculture. The potential of this fast growing clam as a candidate for clam aquaculture is currently being investigated but has not been cultured commercially[16]. Cockle clams have been commercially harvested from Oregon estuaries for many years. Annual landings have ranged from 18,000 to 72,000 lb in the last ten years.

The potential of this fast growing clam as a candidate for clam aquaculture is currently being investigated but has not been cultured commercially

Culture Techniques

Seed Production

Hatchery technology in British Columbia has not yet been developed to make heart cockle seed available on a reliable and consistent basis. Cockles reach a length of about 1/2 in during the first winter and about three inches after four years. Cockles are usually not more than 100 mm in length but can reach 120 mm. There is a great variation in size at any age and is particularly noticeable in the first year. Cockle seed has the highest growth rates in low intertidal and subtidal areas with mud/silt substrate and high marine productivity. Food availability and time submerged under seawater are important factors influencing growth.

Grow-out Techniques

High density grow-out technology has not yet been developed for cockles. However, Manila clam grow-out technology can be used for cockle clam grow-out. Normally, the beach area is prepared for planting by digging out any existing clam populations. This aerates the substrate and reduces competition from wild clams.

After seeding, plots can be covered with a diamond mesh predator netting made of extruded polyethylene, which provides protection from their main predators including scoter ducks, starfish, moon snails and crabs. Optimal mesh size is 1.2cm with smaller mesh sizes discouraged as it increases the trapping of sediment and clogging. Larger mesh sizes fail to protect against predation.

The cockle is an exceptionally hardy animal once it survives its juvenile stage. Cockles may take from 2 to 4 years to reach marketable size. At harvest time, the netting is removed. The clams are dug out of the substrate by hand using a clam rake.

Site Selection

The cockle clam is found below the sand and gravel or on the surface of the sand in the low intertidal to 30 m subtidal depth. The clam lives on beaches and near the mouth of bays on tide flats made of fine to medium sand and also in eelgrass/mud areas. They are associated with other species including Butter clams (*Saxidomus giganteus*) and Native littleneck clams (*Protothaca staminea*). The following table summarizes various biophysical parameters conducive to cockle growth and survival.

Table 3.9.1. Summary of optimal biophysical parameters for cockle culture

Substrate	Fine to medium sand/mud
Tidal Elevation	Intertidal -30 m
Temperature	10-20°C (optimum not known)
Salinity	28-33 ppt (optimum not known)
Exposure	Protected from wave action
Productivity	Phytoplankton- moderate/continuous

A complete species evaluation summary is presented in Section 11. The following table provides general advantages and disadvantages of Cockle culture in British Columbia

Table 2. Summary of advantages and disadvantages of Cockle clam culture

Advantages	Disadvantages
Indigenous to BC, common through-out Central and North Coast with abundance of capable beaches	Efficient culture techniques not yet established
Traditional importance to First Nations communities	Seed availability unknown – no commercial production at this time
Fast growth rate	Profitability and market potential not known
Preliminary culture investigations demonstrate hatchery, nursery and intertidal culture potential	

3.10 KELP PRODUCTION AND CULTURE

Species: Giant Kelp (*Macrocystis inegrifolia*), Laminaria (*Laminaria saccarina*), and Bull Kelp (*Nereocystis leutkeana*). Bull Kelp *(Durvillaea antartic*a)

Culture Type: Deep Water longline

Main Products: Fresh, Dried, Processed – Roe on Kelp products, Human food and food additives, pharmaceuticals, aquaculture and livestock feeds, energy production,

Potential

Kelp includes all the brown macroalgae (also brown seaweeds) and more than 100 different species exist worldwide. Out of BC's 15 different kelp species, five or six have commercial potential. Much of BC's coast offers ideal kelp growing conditions: clean, cold water circulated by strong currents with wave action carrying in nutrients from the Pacific.

Some of the important species of kelp commonly found along the shores of the Northern pacific coast are Giant Kelp (*Macrocystis inegrifolia*), Laminaria (*Laminaria saccarina*), and Bull Kelp (*Nereocystis leutkeana*). Bull Kelp *(Durvillaea antartic*a) is the most prolific one in BC waters, making up 80% of the stock. In favorable conditions, this species can grow from a microscopic spore up to 20 metres in as little as four months.

Kelps can be cultivated commercially and is the third largest global aquaculture value (FAO), the largest grower being China. The cooking name (Japanese) of kelp is Kombu. BC kelp flows into several markets including food and pharmaceuticals, and is sold wet or dry as raw or finished product. Another market could be the feeding and fattening of sea urchins. Overall, about 200 tonnes of wild and cultured kelp are currently harvested. At present, BC's most lucrative kelp product is roe-on-kelp. Harvested under 39 J-licenses, some CAN$22.2 million worth of this high-value delicacy is harvested and sold annually, principally to Japanese buyers.

Kelp is a favourite food of sea urchins and abalone. Sea urchin and abalone farming is a growing activity in Asia and more specifically is now being explored in Canada. The possibility of drying kelp for transportation and re-hydrating it before using it for sea urchin or abalone feeding could increase the kelp demand.

Kelp contains compounds different from those found in green plants. One kelp extract seems to suppress genetic mutations which can cause cancerous growths. Researchers in France and Japan feel that some may be powerful anti-tumor agents. Kelp can also be used to detoxify water by absorbing nitrogenous waste and heavy metals to improve water quality. It can be used as an animal feed, and field trials have been carried out where kelp cultured on rope was delivered to sea urchin barrens to fatten and improve urchin roe. In addition, some studies have also been done for using kelp ingredients for cattle feeds.

Kelp is also used in the production of fertilizers and pesticides for organic farming, and is prepared a variety of ways for human food consumption. Moreover, kelp can be harvested for the production of alginates used as emulsifiers in food products as well as providing food and habitat for fish and invertebrates. Kelp is also consumed as a "sea vegetable" mainly in Asia but also in Chile for example.

Culture Techniques

Kelp farming is fairly simple generally, in that the farms typically consist of simple grids of rope longlines. It takes about 2500 metres of longlines to grid a hectare, and the grids are anchored to the sea floor. Seedlings are attached to the ropes, and when ready for harvest the ropes are pulled up and the kelp is removed.

The complex part of the kelp farming process is the production of seedlings. They are produced in a nursery under controlled laboratory conditions. Microscopic kelp spores divide into filament-like males and females, which produce eggs and sperm. Fertilization and growth of a new generation of kelp (sporophytes) requires 45-60 days.

Site Selection

Kelp naturally grows in mid-intertidal to subtidal zone, where currents and water motion are strong. Water motion has been recognized as a very important factor affecting the quality of cultured Kombu in Japan. Nutrient and gas exchange, both primary factors influencing productivity, are directly affected by water movement but too violent of waters can also limit production. The other important factor is light as kelp growth is a direct consequence of photosynthesis. Kelp does well in cold seawater (around 10 °C). A complete species evaluation summary is presented in Section 11. The following table provides a general advantages and disadvantages of kelp culture in British Columbia

Table 3.10.1. Summary of advantages and disadvantages of kelp culture

Advantages	Disadvantages
Indigenous to BC, common through-out Central and North Coat with abundance of capable sites	Seed availability– little commercial production at this time
Highest immediate potential is stabilizing supply to lucrative Roe on Kelp industry	Profitability and market potential not well explored – Low commercial demand
Fast Growth rate (annual crops)	High biomass relative to low prices ($ per tonne)
Culture methods well established	North Coast site selection requirements not well defined.
Low capital and infrastructure	

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4.0 Site Selection for Shellfish Aquaculture

Table of Contents

4.1 Overview 2

4.2 Biophysical Analysis "Can I Successfully Grow the Species There?" 4

  BCMAFF Site Capability Rating System 5

  Limitations of Existing Biophysical Surveys 8

4.3 Site Suitability Evaluation: "Will an Aquaculture Operation Succeed" 9

  Factors Affecting Suitability for Site Location 10

  Factors Affecting Suitability for Economic Success 11

4.4 Overview of Oceanography of the Central and North Coast Study Regions 18

  Climate Overview 18

  Precipitation and Ice Cover 20

  Overview of Oceanography 20

  Area Specific General Oceanographic Features 25

4.1 OVERVIEW

Site selection is the first and generally most critical step in establishing a sustainable aquaculture facility.

Site selection is the first and generally most critical step in establishing a sustainable aquaculture facility. In fact, the success of an aquaculture enterprise is dependent on the selection of a suitable site. For the long-term sustainability of an aquaculture enterprise, it is good investment sense to select an environmentally sound, low risk site at the outset.

The appropriate location of an aquaculture facility is one of the most effective environmental management tools available to an applicant. While operational and market considerations are important factors, high priority must be given to environmental characteristics of the location.

Poor siting and location has been a significant factor in the failure of aquaculture in some areas, and excessive environmental impacts in others.

Poor siting and location has been a significant factor in the failure of aquaculture in some areas, and excessive environmental impacts in others. Prior to conducting any technical or economic assessment of aquaculture and other activities in the coastal zone should therefore address site selection criteria[1].

Sound principles for the selection of aquaculture sites include:

- site specific investigations should indicate that the site is fundamentally capable of biologically and physically supporting an aquaculture operation;
- aquaculture must be permissible within the coastal land-use areas;
- environmentally sensitive areas should be avoided; and
- aquaculture should be compatible with nearby land uses.

Appropriate site selection can avoid or reduce many problems inherent to aquaculture and further:

- reduce the need for technically based environmental mitigation;
- reduce and prevent costly ongoing management and monitoring measures;
- result in substantial savings in establishment and operation;
- reduce levels of public scrutiny and community

concerns; and

- streamline the approval processes.

Aquaculture is highly diverse with radically differing requirements in terms of site characteristics. Water quality is generally the key to a successful aquaculture operation. While most species grow better in high quality water, some species have very particular requirements and cannot survive without optimal water quality and salinity. Because shellfish farming as practices in British Columbia are generally passive, operators have limited ability to control water quality, which puts further emphasis on the importance of water quality.

experience has shown that unless the sites are biologically and physically capable of supporting the chosen type of shellfish culture, operations will be limited by these aspects for the duration of the culture activities and the culturists will spend their careers compensating for the limitations of their site.

Historically, many shellfish culturists have chosen sites because they were convenient to other aspects of their operation. However, experience has shown that unless the sites are biologically and physically capable of supporting the chosen type of shellfish culture, operations will be limited by these aspects for the duration of the culture activities and the culturists will spend their careers compensating for the limitations of their site.

When describing or choosing a site, the factors that determine a sites potential for supporting a given operation can be divided into two components; a) Biophysical Capability and b) Site Suitability. In short, these can be summed up as the ability of a site to biologically and physically support the species and the type of culture method (biophysical capability) and how well suited a site is to support an economically successful operation (site suitability).

Occasionally this is referred to in simple terms as "will it grow there?" and "can I make money growing it there?". Both of these factors are important and distinct. However before economic suitability can be considered biophysical capability must first be established.

Each of these types of evaluations are further described below:

4.2 BIOPHYSICAL ANALYSIS "CAN I SUCCESSFULLY GROW THE SPECIES THERE?"

Biophysical evaluations examine the capability of a proposed site to support the growth and survival of a given species of interest by examining both biological habitat parameters, as well as physical environmental parameters that affect growth and survival.

The adaptive response of different shellfish species permits some to live within a narrow, specific type of environment while others may be able to survive within a relatively wide range of environmental variation. Within these ranges, there is a series of optima, which represent environmental conditions that are ideal for all biological functions of the organism (e.g., growth, survival, reproduction). Under this set of conditions it is assumed that culture of a particular species would sustain a commercially viable shellfish operation with maximum production and survival acquired for the species employed.

An aquaculture capability assessment is based on those minimum requirements (e.g., temperature, dissolved oxygen, salinity, water depth, current flows and circulation/ mixing patterns) necessary for an aquaculture operation to be viable. This type of evaluation can determine which species are best suited to an area and develop specific recommendations for a given site(s).

A number of environmental variables are recognized as important in estimating the capability of a site to sustain the production of shellfish species. The variables of importance comprise:

Environmental Factors Which Directly Affect Shellfish Growth

- Temperature
- Food Availability

Environmental Factors Which Directly Affect Shellfish Survival

- Wave Height
- Grow-out Position
  - Relative to Low
  - Tide (or Surface)
- Suspended Sediments
- Water Movement (tidal flow)
- Disease Prevalence

Disease Prevalence:
http://www.pac.dfo-mpo.gc.ca/sci/sealane/aquac/pages/title.htm

- Fouling Potential
- Predation Potential
- Substrate (intertidal or subtidal sowing only)
- Beach Slope (intertidal operations)

Environmental Factors Which Directly Affect Shellfish Growth / Survival

- Salinity
- Dissolved Oxygen
- pH

The environmental factors that determine the survival and growth capability of a particular shellfish species may be mitigated to a certain degree by the specific layout used in either of the general culture approaches identified previously. For example, shellfish grown on a longline system can be lowered or raised in order to provide a growing environment characterized by optimum water quality, including phytoplankton levels, salinity, temperature, etc.

In the case of scallop culture, submerged longline systems are often favored over conventional longlines, so that the detrimental effects of tidal or wind-induced wave action can be minimized.

In the case of beach culture, substrates are often modified to provide optimum conditions for the culture of Manila clams. Netting is employed in some cases to reduce the effects of predation on clam seed.

Culture techniques can be modified, on a site-specific basis, so that shellfish growth and survival can be optimized in environments that may be subjected to conditions considered less than ideal for commercial production of a particular species.

Each of the above examples demonstrate that culture techniques can be modified, on a site-specific basis, so that shellfish growth and survival can be optimized in environments that may be subjected to conditions considered less than ideal for commercial production of a particular species. Since such differences may be spatially or temporally significant on a site-specific basis, provisions of accurate site capability criteria are limited to a broader range of culture techniques.

BCMAFF Site Capability Rating System

The Ministry of Agriculture, Fisheries and Food in British Columbia (BCMAFF) has developed an appraisal system for shellfish farming sites[2]. For each environmental variable in question, a species will have a range of critical and preferential levels of tolerance.

Simple numerical models, presented as graphical relationships, which document the range of tolerances of critical environmental factors, can be employed to predict the capability of a habitat to sustain a particular species in a culture situation. The range of tolerances can be assigned numerical values, thus representing a Capability Index for that particular environmental variable. Relevant ratings are weighted and combined to calculate a composite *Site Capability Index*.

Categorical Assignment

Calculated Site Capability Indices for each species and culture type provide an objective rating of the capability of a site for potential culture based on biophysical factors. These values will range from zero (completely unacceptable) to one (optimal).

To facilitate interpretation in the BCMAFF rating system, the relative indicator of a site's potential capability is defined as one of four classes, derived by subjectively dividing the index range into a series of categories for defining a particular site/area.

These rating will only apply to each species and mode of culture for a given site. In each case husbandry elated mitigation, such as seasonal movements of stock, predator control, design of supporting structures, etc. may improve site capability depending on which factors are limiting for a specific site.

The categorical assignments comprise the following:

0.00 – 0.25	**Not Advisable**: Site will not support culture.
0.26 – 0.50	**Poor**: Site may support culture but not recommended.
0.51 – 0.75	**Medium**: Site is capable of supporting culture, and it is highly probable that mitigation may improve culture capability.
0.76 – 1.00	**Good**: Site is recommended for culture. Little or no mitigation is required.

Surveys of the BC Coast

Since 1993, the Provincial government has commissioned surveys of the British Columbia coast to conduct preliminary mapping investigations for biophysical capability. This process has involved extensive oceanographic and beach surveys using a standard methodology[3]. The extensive data acquisition approach is the first step in the process for obtaining information on shellfish culture capability for a particular region. The shellfish culture capability parameters most suited to this survey approach and examined during field programs has included:

- Salinity: summer/winter extremes (bottom culture/off-bottom culture)
- Temperature: summer/winter extremes (bottom culture/off-bottom culture)
- Relative exposure-fetch: distance/direction (bottom culture/off-bottom culture)
- Intertidal slope/composition (bottom culture)
- Tidal height or water depth (bottom culture/off-bottom culture)

Information collected during this field program has been used to develop a map resource and database for most coastal areas of the British Columbia coastline specific to the culture of Pacific oysters, Manila clams and Japanese scallops. This information has been incorporated into a "Shellfish Site Capability System" which is presented in GIS mapping format, an electronic database and in report format.

Reports specific to Central and Northern British Columbia include the following reports:

Blyth, C.A., D.A. Cake, I.E. Laing and B.C. Kingzett. 2002. Shellfish Culture Capability Appraisal for the Seymour and Belize Inlets Region. Prepared for B.C. Min. Agric. Fish. Food. 61pp + app.

Blyth, C.A., M.A. Mallory, M. Sangret, C. Spicer and B.C. Kingzett. 2000. Shellfish Culture Capability Appraisal for the North Coast Region. Prepared for B.C. Min. Agric. Fish. Food. 129pp + app.

Blyth, C. A., A. M. Peacock, C. A. Horne and B.C. Kingzett. 1998. Shellfish Culture Capability Appraisal for the Queen Charlotte Islands Region. Prepared for B.C. Min. Agric. Fish. Food. 46pp+ app

Peacock A.M., C.A. Blyth, C.A. Horne, F.A. Williams, S. F. Cross & S.J. Gormican. 1998. Shellfish Culture Capability Appraisal for South Central Coast Study Region. Prepared for B.C. Min. Agric. Fish. Food. 107pp + app.

Aquametrix Research Ltd. and AXYS Environmental Consulting Ltd. 1997. Shellfish Culture Capability Appraisal for the Broughton Archipelago Study Region. Prepared for B.C. Min. Agric. Fish. Food. 26 + app.

Aquametrix Research Ltd. and AXYS Environmental Consulting Ltd. 1997. Shellfish Culture Capability Appraisal for South Central Coast Study Region. Prepared for B.C. Min. Agric. Fish. Food. 36pp + app.

Aquametrix Research Ltd. and AXYS Environmental Consulting Ltd. 1997. Shellfish Culture Capability Appraisal for Quadra Cortes Islands Study Region. Prepared for B.C. Min. Agric. Fish. Food.

These reports are publicly available through the BCMAFF website at:

http://www.agf.gov.bc.ca/fisheries/Shellfish/shellfish_main.htm

or directly from the following FTP (File transfer) site:

ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/sf_capability/

Limitations of Existing Biophysical Surveys

It is highly recommended that shellfish culturists only use the results of the BCMAFF Shellfish Culture Capability appraisals as a guide to site selection.

It is highly recommended that shellfish culturists only use the results of the BCMAFF Shellfish Culture Capability appraisals **as a guide to site selection**. The categorical assignments have been prepared subjectively, without rigorous field confirmation. The ratings developed in the BCMAFF Shellfish Capability studies are specific for a species and mode of culture for a given site. In each case, husbandry related mitigation techniques such as predator control, design of supporting structures or enclosures may improve site capability depending on which factors are limiting for a specific site.

When considering a specific site or region that has been assessed by this process, the prospective culturist should examine those individual factors (capability indices), which may have reduced the overall site capability rating. Similarly, the prospective culturist should examine what information may be missing from the Site Capability rating, as the site index may be further reduced should information become known about other factors.

Should a specific site be considered attractive as a potential shellfish culture site, the prospective culturist is well advised to implement an intensive sampling program to provide a more thorough site-specific evaluation of the site's capability.

Furthermore, one would be well advised to employ this model as a guide to a thorough site evaluation, which should then employ grow-out trials prior to engaging in commercial operation.

4.3 SITE SUITABILITY EVALUATION: "WILL AN AQUACULTURE OPERATION SUCCEED"

Suitability evaluations examine the ability of a proposed site to meet socio-economic requirements that support the commercial viability of a proposed operation. These include the identification of factors that affect both aspects of initially locating the site and the operational costs that will be associated with operating the site.

In summary, these are factors that affect the process of obtaining the initial approval to develop a given site which, will in turn, affect the economic success of an operation working on that site.

For further discussion these have been broken down into two groups:

- ☐ Factors affecting suitability for site location
- ☐ Factors affecting suitability for economic success

Defining or rating suitability criteria is difficult, as various individuals depending on their individual situation or business plan will view some factors differently.

Defining or rating suitability criteria is difficult, as various individuals depending on their individual situation or business plan will view some factors differently. For example, a remote site has little appeal to an individual living in a major centre but may be well suited to an individual who is already living in a remote community.

Properly judged in light of the desired use and individual business plan, a site which has high suitability for shellfish culture will have few resource conflicts in its selection, provide environmental sustainability and provide a basis for economic success.

Factors Affecting Suitability for Site Location

In some cases site layout, design or restrictions on operations may mitigate factors which might otherwise restrict the availability of a certain location. The following list of factors must be considered during the initial site suitability evaluation in order to determine whether approval may be given for a specific tenure:

Regional Zoning Designations

Aquaculture must be permissible within the land use zones as established by the relevant government authourity.

Competing Resource Uses

A proposed aquaculture operation should not negatively impact competing resource uses including: recreation and tourism, anchorages, marine protected areas, forestry, existing/proposed upland and marine development (residential, agricultural and industrial, commercial, aboriginal or recreational fishing).

An evaluation of resource uses must also take into account important cultural or heritage sites and aboriginal use areas. Indirect resource conflicts may include factors relating to upland concerns of the presence of aquaculture operations within the "View shed" of upland settlement or recreational usages. This is becoming an increasingly contentious issue for aquaculture within the Strait of Georgia and is related to social concerns (see below).

Site design or lay-out may mitigate some of these conflicts. In some instances potential benefits from aquaculture activities may be perceived to out-weigh negative impacts of other uses. The examination of resource conflicts must also include related and cumulative effects of the proposed development, which may have conflicts with activities that may not be directly at the proposed locations.

Similarly, other local resources uses should be examined to avoid locating shellfish aquaculture operations that may be impacted by other coastal resource activities (e.g., pollution).

Social Concerns

In recent years, coastal resource management has changed to take into account community objectives in determining what types and uses of the coastal foreshore are acceptable. Occasionally, these may become highly contentious. The definition of "community" has become broad and may include persons, companies, and residents directly adjacent or affected by coastal uses, local regional districts, First Nations and to a lesser extent, the coastal community at large.

Prior to initiating any new aquaculture ventures, both the corporate and community objectives must be examined and established. This will provide guidelines for making future business and community decisions. Community and social objectives may include, for example; priority species for culture, acceptable levels or rates of development, types of development or areas that may or may not be appropriate for development.

Environmental Parameters

Environmentally sensitive areas should be avoided (e.g., sensitive fish habitat, critical wild-life habitats). Typically in siting shellfish operations in British Columbia the habitats of greatest concern include spawning channels or grounds, eelgrass beds or rocky reef habitats. Important bird nesting or foraging areas may also be important considerations.

Factors Affecting Suitability for Economic Success

Sufficient Size of Site

Sites should be of a minimum size to provide the necessary amount of growing area that will support enough production to justify the economies of scale required for economic success. This should also take into account future potential growth of the operation. Access to multiple sites within a company's area of operations may be an alternative, to the size of individual sites. As an estimate, the BC Shellfish Growers Association has stated that 10 hectares is a sufficient minimum for deep water operations.

Distance from Point of Landing

The distance that an aquaculture operation is located from its "home port" or the point at which harvested product will be landed, is often the single most important factor in determining a site's suitability as many of the factors below become related to this distance. The distance traveled to access the site will determine fuel costs, size of vessels required to access the site and transport harvested product and whether or not on-site accommodation will be required.

Evaluating this factor must also take into account how difficult it may be to travel exposed waterways year round. Depending on markets, business plans should assume that access to the site must be possible year round.

Provision of Regulatory Monitoring Services

Marine waters from which bivalve molluscan shellfish are harvested or grown must be monitored, evaluated for pollution and classified in order for approved harvesting to take place. It is necessary that the water quality of shellfish growing areas be surveyed, and that actual and potential pollution be identified so as to minimize potential health risks associated with consuming shellfish.

Primary responsibility for regulatory monitoring rests with Environment Canada and the Canadian Food Inspection Agency through the **Canadian Shellfish Sanitation Program (CSSP)**. The CSSP program assures that shellfish come from pristine growing waters. The designation of safe growing waters, the patrolling of shellfish harvesting areas, and the harvesting, processing, and distribution stages of the shellfish industry are all regulated by this program.

More background about the CSSP and sanitary monitoring services may be found at Canadian Shellfish Quality Resource website[4]

Sources of contamination which can affect shellfish, and for which they are monitored, include the following:

- Raw sewage from malfunctioning or improperly constructed domestic septic systems and tile fields;
- Urban and rural landwash containing organic wastes, pesticides, fertilizers, petroleum residues, metals or other pollutants;
- Direct discharges of raw sewage from boats and shoreside residences;
- Industrial discharges of metals, pesticides, chlorinated organic compounds or other pollutants;
- Direct discharges of raw sewage via municipal outfalls;
- Wildlife, domestic animals, congregations of marine mammals or birds and;
- Blooms of toxic phytoplankton species (Harmful Algal Blooms).

In order for sites to harvest farmed shellfish they MUST be classified as APPROVED GROWING AREAS, which requires that appropriate monitoring, services are provided. Much of Central and Northern British Columbia is not yet monitored sufficiently. The North Coast Water Quality and Marine Biotoxin Society is working with Environment Canada and the Canadian Food Inspection Agency to develop and maintain monitoring services on the British Columbia North coast[5].

Due to the sensitivity of shellfish to pollution and the potential for terrible consequences for shellfish farmers, the shellfish growing industry is focused on maintaining and promoting a clean environment with pristine water sources.
Oil spills, marine traffic, contaminated runoff, new commercial or residential developments, industrial expansion and illegal dumping are examples of events that are monitored by the wary grower.

Shellfish regulatory monitoring services encompass the Harmful Algal Blooms, sanitary (sewage) pollution and other man- made (anthropogenic) pollution sources. These site suitability factors are each described individually below.

Frequency and Duration of Harmful Algal Blooms (HABS)

In BC, the Canadian Food Inspection Agency (CFIA) is responsible for analyzing samples of shellfish for paralytic shellfish poisoning toxin (PSP - saxitoxins) and amnesic shellfish poisoning (ASP - domoic acid).

As the basis of the marine biotoxin monitoring program in the Pacific Region, large mussels are hung in plastic mesh sacks in shellfish growing areas (in addition to a lesser number of commercial samples of all species). Samples are withdrawn on a weekly or biweekly basis and shipped to the CFIA laboratory for analysis.

Shellfish species differ in their tendencies to accumulate and eliminate marine biotoxins in their tissues. Mussels tend to be nonselective feeders of phytoplankton and are therefore much quicker to pick up biotoxins than many other shellfish species. The levels of biotoxin in mussels are frequently up to 10 times higher than oysters and Manila or Littleneck clams growing in the same area. This allows the CFIA to recommend harvest restrictions (e.g., area closures) to Fisheries and Oceans Canada while species other than mussels such as clams, oysters and scallops are still safe.

In some areas of the coast marine biotoxin events are a regular event and may restrict shellfish culture opportunities especially for culture products like whole scallops, which retain biotoxins for a long period of time. Marine biotoxins may not be artificially purged or depurated but must be allowed to cleanse naturally during which time CFIA will close affected areas for harvesting.

An evaluation and summary of Canadian Food Inspection Agency historical marine biotoxin records for the areas should be undertaken as a component of a full site evaluation. Business planning for a specific site should reflect the duration of bloom events that may be experienced at that site. Unfortunately, there is limited data available for Central and Northern British Columbia. The North Coast Water Quality and Marine Biotoxin Society are compiling what data exists.

Growing Water Classification (Sanitary Survey)

Sanitary water quality surveys are used to determine whether shellfish growing waters are appropriate for the harvesting of shellfish. The sanitary assessment of growing areas identifies and evaluates those factors influencing the sanitary quality of the water. Shellfish growing water surveys can be divided into two components: bacteriological surveys and shoreline surveys. The former refers to the measurement of faecal coliform pollution indicators in the growing areas, while the latter describes the studies required to identify and quantify possible pollution sources including movement, dilution and dispersion of possible pollutants in shellfish growing areas. The primary objective of the surveys is to reduce bacterial contamination such that the consumers are protected from potential threats associated with eating contaminated shellfish.

Following such surveys, the actual and potential growing areas are classified as to their suitability for the harvesting of shellfish according to accepted water quality criteria and general sanitary conditions in the growing area. Depending on water quality and the results of the shoreline and sanitary surveys, several classifications are possible which permit or restrict varying degrees of harvesting. Shellfish growing areas in Canada may be classified as Approved, Conditionally Approved, Closed or Prohibited. Each classification is based on the bacteriological quality of the growing waters and the known potential sources of pollution.

A complete site evaluation should examine Environment Canada historical sanitary survey records and harvest classification for areas of interest.

Anthropogenic Impacts

Aquatic contaminants that may directly or indirectly affect shellfish growth and survival, include those derived from industrial (e.g., pulp mills) or commercial (e.g., marina) facilities. Pollution types which are investigated include, metals, chlorinated organic compounds, petroleum products and other organic compounds. Pollutants are monitored due to their potential to cause acute health effects, and delayed or chronic illness that may result from repeated ingestion of minute amounts. Several organic and heavy metal pollutants are persistent in shellstock tissues and may accumulate over time. Once contaminated, these animals, for all practical purposes, may never become adequately purified for safe consumption.

Ensuring an adequate distance from all potential pollution sources will eliminate association with potentially detrimental anthropogenic compounds.

Availability of Workforce

Finding and keeping a trained workforce in remote operations is a significant factor in site success. Sites must be able to attract and keep good employees and managers. This requires having sites either within safe daily commute range of a population centre or sites that provide sufficient accommodation facilities. However, the addition of crew accommodation to a business plant will significantly increase expenses.

Access to Supply Inputs

This is another important logistical factor which is often related to infrastructure and distance to the site. A reliable supply of reasonably priced inputs is important including services (vessel and equipment repair), miscellaneous supplies and consumables (equipment, fuel, etc.) and specific grow-out materials. This includes access to seed. Freight and logistical concerns related to importing materials will significantly affect operational costs.

Access to Markets

This factor is difficult to define and is dependent on specific markets and logistical concerns relating to freight of landed product and location of buyers and processors for farmed shellfish products. Shellfish farming sites should ideally have ready access to buyers, processors and/or wholesale/retail markets. Site specific business planning must take market access into account when deciding on aspects such as culture species, culture methods, products and economies of scale.

Availability of Utilities

At some point, most aquaculture operations will require electricity which could be provided by generator or alternative energy sources. Operations that require continuous power such as pumping or FLUPSY operations may require access to hydro power.

Port Infrastructure

Shellfish aquaculture once in production will require significant tonnages of product being landed. Business planning should insure that the home port for a given site has access to cranes, ramps or dock facilities sufficient to land bulk shellstock. If this is not available then provisions should be made for offloading at another location or insuring that the operation supplies sufficient equipment for product transfer.

Provision of supplies and services for a given site such as fuel, equipment, freight and the distance from the site under evaluation should be considered. Available moorage, where product will be landed, may also be important.

Foreshore Accessibility

If possible, sites should have the opportunity for local upland foreshore access to be used for equipment storage and accommodation if necessary. Operations that have road based foreshore access are advantageous.

Distance from Other Operators

This may be a negative factor especially where disease is a problem – although this is not typically an issue in shellfish culture. For many types of shellfish culture the reverse is true, where an operation will benefit from neighboring farms or clusters of farming activities that will support shared infrastructures.

Site Security

Depending on the species under culture and production techniques, sites may be vulnerable to theft or vandalism. Consideration should be given as to how large a risk this entails and how site security may be provided.

4.4 OVERVIEW OF OCEANOGRAPHY OF THE CENTRAL AND NORTH COAST STUDY REGIONS

The coast consists of a complex network of waterways comprised of passages, channels, inlets and numerous islands.

The study area considered in this project extends from Queen Charlotte Sound in the south, north to the Canada/United States border to include Portland and Observatory inlets. The study region also includes the Queen Charlotte Islands archipelago. The coast consists of a complex network of waterways comprised of passages, channels, inlets and numerous islands.

Fundamental to the selection of potential aquaculture sites within the study region is an understanding of the larger scale oceanographic processes

Fundamental to the selection of potential aquaculture sites within the study region is an understanding of the larger scale oceanographic processes, which ultimately determines the biophysical capacity of the region. The following general review provides an overview of the climate and oceanographic processes in the region.

The Coast Mountains, with elevations of 1,219 to 3,362 m, help to define the oceanographic and climatic conditions that influence the mainland coast. The steep terrain has a profound effect on the approaching offshore storm systems and interior outflow winds, causing the air masses to funnel through the waterways with increased intensity. Numerous rivers emptying into the system from the mainland influence the current regimes and hydrography of the region. The deep U-shaped basins that are typical along the coast are the water-filled remnants of the glacier-formed valleys. Many of the long, narrow inlets and channels have a glacial-mud bottom, a shallow sill at the entrance and freshwater input at the head. These characteristics potentially give rise to freshwater entrainment in the surface waters, low oxygen conditions in the deeper waters and heavy siltation.

Climate Overview

The study area is a subarctic, maritime climate zone characterized by mild winters and cool summers. Generally, the climate is influenced by two offshore pressure systems situated in the North Pacific, named the winter Aleutian Low and the summer North Pacific High.

The study area is a subarctic, maritime climate zone characterized by mild winters and cool summers.

The Aleutian Low centred in the Gulf of Alaska generates predominantly southwest winds during the winter months. From early October to the latter part of December the prevailing winds are from the southeast and east, and are frequently gale force, accompanied by heavy rainfall. The change to offshore winds from the northwest or north and northeast generally occurs from the latter part of December to February. During February through April, the prevailing winds are from southeast and east.

The area is subject to significant storm events. Maximum gusts of between 148 and 161 km/h have been recorded in the study area (McInnes Island, Cape St. James). Winter winds of greater than 48 km/h have been reported to last for durations of more than 40 hrs.

Maximum gusts of between 148 and 161 km/h have been recorded in the study area

Winter weather systems also include polar outflow events with cold arctic air from the mainland interior funneling out of the coastal inlets at high velocities creating severe wind waves. During clear, cold weather a vast pool of very cold air accumulates on the interior plateaus and is contained there for some time by the great mass of the coastal ranges. Eventually some mechanism, usually a fall in pressure in the offshore area, triggers the movement of this air towards the coast. The orientations and narrowness of the major inlets accentuate its normal gravitation towards sea level. In some locations the winds are accompanied by freezing spray.

Polar outflow events with cold arctic air from the mainland interior funneling out of the coastal inlets at high velocities creating severe wind waves.

Burke and Dean Channel are the prime coastal corridors for polar outflows along with Knight Inlet and Gardner Channel. Winds in the larger reaches of Burke and Dean Channel may exceed 100 km/h during these events and in mid winter, winds greater than 66 km/h (Beaufort Force 11-12) have been recorded in the upper reaches of Rivers Inlet. The occurrence and effect of these polar outflow winds in the coastal inlets can be devastating to potential aquaculture siting.

During the summer, the prevailing northwest winds which emanate from the North Pacific High result in cool ocean air flowing onto the coast. Westerly winds are predominantt during May and change to south, southwest and west from June to September. Northeast winds during summer months are rare. It should be noted, however, that strong southeast or northwest breezes could occur in any season.

During the summer, the prevailing northwest winds which emanate from the North Pacific High result in cool ocean air flowing onto the coast.

Also important in many of the inlet systems are summer diurnal winds, which result from the cooling and warming trends of inland landmasses. These winds, which may exceed 30 km/hph, create high, short, funneling waves that run landward in the afternoons and seaward at night and in the early morning. These diurnal flows may be significant enough to prohibit the use of various waterways for culture use.

Although many inlets on the West coast are enclosed, they are subject to violent squalls during strong southeast gales travelling through the valleys leading into the inlets. Williwaws, which are violent wind squalls usually of short duration, may be experienced near the mouths of narrow inlets due to the seaward drainage of cold air from high ground through the narrow valleys or fjords common to the area.

Precipitation and Ice Cover

Annual precipitation for the region is in excess of 3,000 mm (118 inches) per year on average with local areas receiving 5000-6000 mm annually

Total annual precipitation for the region is in excess of 3,000 mm (118 inches) per year on average with local areas receiving 5000-6000 mm annually and with 5-7 day storm events producing 100-400 mm of precipitation. On the outer coast, precipitation averages 2400 mm/ year. Peak 24 hour rainfalls may exceed 200 mm, with the highest overnight rainfalls experienced between October and December.

The moderating influence of the ocean prevents the occurrence of persistent snow in the offshore area. However, in winter, the influence of the colder air in the interior results in heavy snowfall in the more protected fjords and waterways. The combination of heavy rainfall and freshwater input from the numerous river systems result in reduced surface salinity and potential for winter freeze-up in the inner reaches. Many North coast inlets freeze-over for weeks at a time. Freeze-over conditions are more prevalent at the heads of inlets due to reduced salinity levels and therefore, it is recommended that operations minimize potential exposure to this problem.

Overview of Oceanography

An extensive historical review of the oceanography of the area, with special reference to aquaculture, has been prepared by Ricker and McDonald (1995),[6] and the reader is urged to consult this work for further detail regarding the oceanography and other biophysical and suitability factors regarding the region.

Extensive inshore temperature and salinity data has been collected during BCMAFF sponsored biophysical surveys, which include temperature and\or salinity data to approximately

50 metres. However, it should be noted that during each season there will likely be variations in water conditions at each site, due to differences in seasonal weather patterns or runoff conditions that are being experienced (e.g., during heavy rains, polar outflows, or hot/dry weather). This data set therefore, represents only typical subsets of the general conditions that can occur during each season and wider range of variation may be experienced.

The following overview summary of has been compiled from previous biophysical survey reports and Ricker and Macdonald, (1995).

Major Water bodies

The major bodies of water that influence the Central and North mainland Coast and Queen Charlotte areas and affect the oceanography and climate of the region include the North-eastern Pacific Ocean, Queen Charlotte Sound, Hecate Strait, Dixon Entrance and Queen Charlotte Strait

The North-eastern Pacific Ocean borders the west side of the Queen Charlotte Islands and generates most of the climate and oceanographic effects experienced on the Central and North coast. Proximity to the edge of the continental shelf on the west coast results in the oceanography being influenced by coastal upwelling of deep, cool nutrient-rich waters especially on the West coast of the Queen Charlotte Islands.

The Alaska Current of the Northern Pacific Subarctic Current generally sets towards the shore and then north towards the Gulf of Alaska along the west coast of the Queen Charlotte Islands. This near shore current may be reversed by strong winds from the north to northwest, which force the Alaska Current seaward causing eddies and insular currents in near shore areas.

The wind and tidally driven waters of the Pacific Ocean move inshore over the shallows of Queen Charlotte Sound and Hecate Strait, resulting in outer shores and waterways impacted by moderate to heavy seas. Queen Charlotte Sound is situated on the mainland coast between Vancouver Island and the Queen Charlotte Islands and, coupled with the northeastern Pacific Ocean, this directly influences the southern portion of the study area.

The northern boundary of the study region is defined by Dixon Entrance, a deep trough separating the north end of Queen Charlotte Islands from Dall and Prince of Wales Islands, continuing east to the entrance of Portland Inlet.

Hecate Strait separates the mainland coast from the Queen Charlotte Islands. The strait is a submarine valley, narrowing sharply in the north with the deepest section located along the mainland shore. Depths in the strait diminish from around 164 metres in the south to about 50 metres in the north. The west side of the northern three-quarters of the strait is a broad platform of glacial sands and gravels; depths decrease northward from 90 to 20 metres adjoining the flat coastal plain of Graham Island. To the south, the Queen Charlotte Strait basin has a deep irregular bottom, which causes tidal turbulence.

Tides and Currents

Tides on the British Columbia coast are a mix of diurnal (one day period between highs) and semi-diurnal (half day period between highs) components.

Tides on the British Columbia coast are a mix of diurnal (one day period between highs) and semi-diurnal (half day period between highs) components. The amplitudes of both components increase slightly as the tide travels north and there is an even greater increase in the semi-diurnal portion. The semi-diurnal characteristic extends into the inlets all along the coast. Typically, tides range from 3-5 metres. The greatest tidal ranges are found in the waterways near Prince Rupert, where the range of the largest tides is approximately 7.3 metres. Sea levels may rise up to one metre above the predicted tidal height during the autumn storm cycles tidal as southwest winds "push" water towards the coast.

The flood tide generally comes in from Dixon Entrance and meets the flood coming up from Hecate Strait from the south in the vicinity of Porcher Island. In late summer, mid July to September, the tides meet 25-30 nm south. The flood stream from Dixon Entrance, on reaching the northern end of Hecate Strait, divides at a mid-point between Rose Spit and Dundas Island. In winter the flood and ebb tides are quite regular, while in late summer the flood greatly exceeds the ebb. In August flood tides can reach 2.5-3 knots with little appreciable ebb or slack water. Farther south, where the strait widens in the latitude of Porcher Island, the currents rarely exceed 1 knot.

Off the south end of the Queen Charlotte Islands, the direction of the flood is northeast and the ebb is southeast. The non-tidal

Alaska Current sets northwest along the west coast of the Queen Charlotte Islands at about 0.5 knots during normal weather, increasing to 1 or 1.5 knots with strong southeast gales. This current will generally accentuate the flood stream and conversely the ebb.

The tides and winds primarily generate the current streams of the inside waterways. However, freshwater run-off, atmospheric pressure, bottom topography and irregular shapes of channels may alter the resultant flow rates. The south end of Tolmie Channel, north of Klemtu, is an example of a narrow passageway that is not only effected by wind and tide, but also by the surrounding terrain. The irregular bottom topography around Parry Patch and in Sarah and Jane passages lends to stronger and more turbulent tidal currents.

In most of the inlets, the times of high and low waters and the range of tide are substantially the same at the head as at the mouth because their natural periods of oscillation are substantially less than the semi-diurnal tidal component periods. In long channels with a north and south entrance (Grenville, Principe, Devastation and Princess Royal and Laredo channels), the flood enters from both ends and meets in the middle of the channel where the tidal currents are usually weak and variable. The ebb current usually flows out of the inlets and channels in the exact opposite direction to that of the flood streams. In general, the rates are not very strong except in restricted areas.

In a few reaches, such as Cornwall Inlet off Whale Channel, tidal flow is restricted at the entrance with the resultant times and tidal heights differing from the surrounding waterways.

In the deep and fairly uniformly wide inlets and channels, the seaward flow of freshwater runoff from rivers is confined to the surface layer. In the summer months, heavy runoff may cause a continuous seaward flow where the influence of the tidal currents is apparent only as a periodic increase and decrease of that flow. In and near narrow and restricted passages, the tidal flow is usually strong and turbulent; there is a complete mixing of the different layers of water; and the residual seaward freshwater outflow becomes relatively insignificant. In these cases, the to-and-fro movements of the tidal currents are predominant. This characteristic is present in some of the waterways of Prince Rupert Harbour.

In the deep and fairly uniformly wide inlets and channels, the seaward flow of freshwater runoff from rivers is confined to the surface layer.

General Seawater Salinity Trends

Sea surface salinity distributions are influenced by the open ocean waters and by seasonal variations in wind, tide and river outflow. The major inlets in the region are categorized as High and Intermediate run-off fjords[7]. The coastal waterways are influenced by low salinity, estuarine surface waters that are generated by the large river and glacial run-off systems situated at the head of the fjords.

The general trend in coastal waters is a decrease in surface salinity values from the outer coastal areas to the head of the inlets, with low salinity occurring during both spring/summer freshette and in autumn through to early winter. Where the brackish waters meet the oceanic waters in the outer regions, a complex series of circulation patterns arise. However, these patterns are not fully understood. Low salinity waters may reach depths of up to 15 metres during certain times of the year.

Low salinity waters may reach depths of up to 15 metres during certain times of the year.

Autumn is the main time of discharge for coastal streams as a function of rainfall events. Whereas in late spring and summer, the large river systems are affected by draining mountain snow packs. During conditions of minimal tidal exchange, weak winds and/or strong estuarine entrainment, the water column becomes stratified and surface salinity values decrease. During large tides, with high winds and minimal freshwater input, the waters become homogeneous. At the head of some of the inlets and bays, a freshwater layer may develop overlaying the denser, saline water. As a result, during polar outflow events arising out of the interior of the province, the surface waters, along with intertidal areas, have a tendency to freeze-over during winter.

General Seawater Temperature trends

Sea surface temperatures on the outer coast vary from about 8°C off Vancouver Island to 6.5°C off Dixon Entrance at the north end of the Queen Charlottes during winter. With decreased storm activity and increased solar radiation, the upper layers of the water column warm as the summer advances and by August/September surface temperatures increase and the temperatures range is between 11.5°C and 15.5°C with highs of 20.0°C. During summer when the prevailing westerly winds are blowing, the sea temperature may fall to 10.5°C to 11.5°C as a result of the upwelling. Sea surface temperatures may increase in calm embayments with minimal tidal circulation and wind

During summer when the prevailing westerly winds are blowing, the sea temperature may fall to 10.5°C to 11.5°C as a result of the upwelling.

waves. Both surface and deep-water temperatures are considerably cooler in the northern inlet systems due to the influence of snow melt from the Coast Mountains. Deeper water temperatures are typically cooler that surface waters but are still heavily influenced by the cool freshwater input.

Area Specific General Oceanographic Features

North Coast

North Coast regions are significantly affected by freshwater inflow from the Skeena and Nass drainage systems.

North Coast regions are significantly affected by freshwater inflow from the Skeena and Nass drainage systems. Typically, minimum surface salinity values show heavy influence of freshwater input into the heads of many of the inlets and channels. Higher salinity waters are notable in the outer waterways. The winter surface salinity values are higher than in the summer and the deeper salinity values (5-20 m) are typically higher than surface values. However, significant freshwater dilution is present particularly in Douglas and Devastation channels, Gardner Canal and Portland Inlet waterways.

Freshwater dilution is also evident in Prince Rupert Harbour, near the head of Kitimat Arm, in Kitkatla Inlet. However, this trend is not nearly as pronounced as in the summer months. In winter months salinity values are much more uniform throughout the North coast. Typically values range from 25 (parts per thousand) ppt to 32ppt, with the majority of stations recording values in excess of 30ppt.

Surface water temperature values are also very uniform throughout the northern area. Sheltered waters appear to be slightly warmer than the more exposed outer portions of the North Coast area. Summer sea surface temperatures are generally colder in the outer coastal areas than in the more protected channels and inlets. However, cold, freshwater runoff in the summer does significantly lower surface temperatures in some waterways (e.g., Gardner Canal and Douglas Channel).

The outer waterways adjacent to Hecate Strait are the most exposed areas and are subjected to heavy winds and seas generated from prevailing southerly and westerly storm systems. The main channels of Chatham Sound, Portland Inlet, Principe and Squally channels experience the winds and waves to a lesser degree than the outer areas. Further inland, there is a lesser impact on the headwaters and small embayments off these major passageways.

Central Coast

In the Central coast regions minimum surface salinity values (0-5 m) for the study area show heavy influence of freshwater input into the heads of many of the inlets and channels in the study area.

The high run-off fjords including Burke Channel, Dean Channel, Rivers Inlet, Fitz Hugh Sound and Fisher Channel are characterized by the drainage of stored run-off from large glacial ice melt during the summer. The intermediate fjords including Roscoe, Draney and Smith Inlets have large spring run-off as a result of the spring thaw, but have a relatively low autumn and summer estuarine outflow.

Higher salinity waters are notable in the outer waterways and in Finlayson Channel (see Figure 2). Minimum salinity values for surface waters are lower in Spiller and Mathieson Channels and in Sheep Passage during the winter. For a majority of the Central coast study area, the winter surface salinity values are higher than in the summer and the deeper salinity values (5-20 m) are typically higher than surface values.

Both surface and deep-water temperatures are considerably cooler in the northern inlet systems due to the influence of snow melt from the Coast Mountains.

Both surface and deep-water temperatures are considerably cooler in the northern inlet systems due to the influence of snow melt from the Coast Mountains. The most heavily effected areas are Spiller, Whale and Ursula channels and Fraser Reach where the maximum summer surface temperatures are generally less than 12.6°C. Deeper water temperatures are typically cooler than the surface waters, but are still heavily influenced by the cool freshwater input.

The water column of Queen Charlotte Strait is transitory between an open oceanic regime and the estuarine character of its tributary channels and adjacent high run-off fjords that drain a large glacierized area of the Coast Mountains.

Queen Charlotte Strait

The water column of Queen Charlotte Strait is transitory between an open oceanic regime and the estuarine character of its tributary channels and adjacent high run-off fjords that drain a large glacierized area of the Coast Mountains. The waters exhibit a cool mean temperature of 8.6°C. Pine Island lighthouse records have indicated it to be the coldest seawater observation station along the entire coast, due to upwelling and turbulence. Queen Charlotte Strait is at the edge of vigorous coastal upwelling as a consequence of long wind fetch over

Queen Charlotte Sound, with up-welled cold waters penetrating into the strait by tidal forces.

Currents in Queen Charlotte Strait consist of tidal, estuarine and wind-driven components. The tidal range found in the waterways of Queen Charlotte Strait, approaches 5 metres. The lowest variation is found throughout the inland waterways of Seymour and Belize inlets, varying less than 2 metres at spring tides.

Seymour Inlet's flushing characteristics are compromised by a very narrow, shallow-silled, entrance (Nakwakto Rapids). During a tide change the inlet never fills, nor empties to the same level as the outside seaway. That is, when high or low tide is reached on the outside, the inlet is still filling or emptying and equilibrium with the seaway is reached after tide change has occurred in Slingsby Channel and Schooner Entrance. Hence, the tidal range of the inlet is compromised by one meter on the average because the outlet is too constrained to allow a full tidal exchange. This is reflected in the salinity, which is lower than other inlets. Oceanic water does not reach the head of several of the waterways in the study area, and low dissolved oxygen levels are expected below entrance sill depth, particularly in bodies such as Allison Sound and Schwartzenberg Inlet that have shallow entrance sills.

Similar patterns of circulation are found in other confined or lagoon systems along the Central coast, such as Kildidt lagoon on Hunter Island for example.

Queen Charlotte Islands

Water temperatures vary considerably throughout the archipelago with exposed coastal areas averaging much lower temperatures than the large protected inlet systems.

In the Queen Charlotte Islands, measured surface salinity values are highest during the summer and lowest during winter. On average summer surface salinity values are higher on the east coast of the islands, moderate on the west coast and lower in Naden Harbour and Masset Sound. Tasu Sound has lower surface salinity values, on average, likely influenced by the sound's narrow entrance. Deeper salinity values (5-20m) are higher than surface values with a majority of the southern area in the 30.3 to 31.6 ppt range for minimum summer values. Naden Harbour and Masset Sound have considerably lower values in the range of 20.9 to 28.3 ppt.

Water temperatures vary considerably throughout the archipelago with exposed coastal areas averaging much lower temperatures than the large protected inlet systems. Masset Inlet, Tasu Sound and Skidegate Inlet are the warmest areas in the study area, with summer surface temperatures in excess of 16°C in the inner portions of Masset Inlet. The less protected regions of the study area have average summer surface temperatures in the 13.5-14.7°C range.

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5.0 Territory Specific Discussion

Table of Contents

5.1 Introduction 2
5.2 Methodology 3
  Capability 3
  Suitability 5

As local information provided by First Nations representatives is considered confidential, individual reports have been prepared on a specific territory basis and provided to First Nations only. Only methodology used to produce the analysis and subsequent GIS products is provided in this public version of the Shellfish Aquaculture Business Strategy.

5.1 INTRODUCTION

This analysis is limited to a designated area of "shellfish culture interest"

A synopsis of known information regarding site capability and suitability for areas of shellfish culture interest for each first Nation on the Central and North coast of British Columbia is provided in this section. This analysis is limited to a designated area of "shellfish culture interest" based on nearshore portions of known traditional territories, and where available, input from First Nation representatives. In some cases, adjustments were made to include entire inlets, bays island groups and other geographical features.

This synopsis includes:

- ☐ An overview of previously collected reconnaissance level biophysical information for oysters, scallops and Manila clam from BCMAFF studies.
- ☐ Local information from First Nations representatives for specific areas submitted as a result of this study.
- ☐ Other information available from federal and provincial sources including tenures, closure areas and known land use information

It is important to recognize that available biophysical information previously described in the Section 4.0 and which formed the basis for the capability analysis has been collected for oysters, scallops and Manila clams only. However, this information is also relevant when evaluating deepwater areas of for the culture of blue mussels or beach areas for potential cockle aquaculture. As a general rule areas that are rated good or moderate capability for oysters or scallops will also demonstrate biophysical capability for mussels, which have a relatively high tolerance of environmental conditions. Although techniques for cockle aquaculture are still experimental, it can be expected that cockle aquaculture will be best developed on beaches existing cockle habitat. Similarly the presence of known habitats or presence of indigenous species such as abalone, green sea urchins or kelp may be used as an indicator when specific requirements for other species are not well established.

With any species, proposed aquaculture siting studies should utilize the data presented here only as a reconnaissance level guide and should confirm proposed sites with detailed site investigatory studies and test grow-out studies.

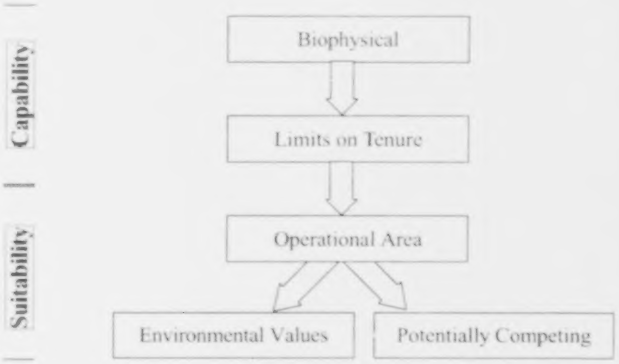
With any species, proposed aquaculture siting studies should utilize the data presented here only as a reconnaissance level guide and should confirm proposed sites with detailed site investigatory studies and test grow-out studies.

As local information provided by First Nations representatives is considered confidential, individual reports have been prepared on a specific territory basis and provided to First Nations only. Only methodology used to produce the analysis and subsequent GIS products is provided in this public version of the Shellfish Aquaculture Business Strategy.

5.2 METHODOLOGY

The intent of the mapping exercise is to highlight areas of opportunities and areas of potential constraints for shellfish aquaculture.

Optimal areas for deepwater and beach culture of shellfish were mapped by taking into account site capability and suitability as discussed in Section 4.0. A diagram of the overall approach is presented below. The intent of the mapping exercise is to highlight areas of opportunities and areas of potential constraints for shellfish aquaculture. While the results indicate general areas to explore further or avoid, it is important to note that this mapping analysis does not take the place of a detailed site evaluation.



Capability

Biophysical assessment is based on the minimal environmental requirements for successful growth

Capability refers to the capacity of an area to support shellfish aquaculture. The capability assessment modifies biophysical assessment with current limits on available tenure areas (see Table 5-1 for a list of data themes). Biophysical assessment is based on the minimal environmental requirements for successful growth, such as temperature, salinity and tidal flow. The biophysical assessment model rates beaches (for clams and oysters) and deepwater areas (for scallops and oysters) into four categories: Not advisable, Poor, Moderate and Good. Biophysical capability data were provided by the Ministry of Agriculture, Fisheries and Food. For this analysis, we included only those beaches and waterways which were rated Moderate or Good for any species. The biophysical assessment thus provides the basis for defining optimal areas.

The biophysical assessment identified the maximum potential area for shellfish aquaculture. However, it does not take into account constraints placed by existing tenures or otherwise occupied foreshore and marine area. Therefore, locations of existing log booms, and finfish and shellfish aquaculture were 'subtracted' from the capability assessment since existing tenures preclude opportunities for new shellfish aquaculture tenures. Tenure information was received from Decision Support Services, Ministry of Sustainable Resource Management. It should be noted that only information from 1995 was available and therefore some additional tenures may be in place. Marine parks were also subtracted from the capability assessment. Although shellfish aquaculture is not expressly prohibited from parks, like any commercial venture the activity has to be judged on whether it is necessary to preserve or maintain the recreational values of the park involved. Shellfish aquaculture development is unlikely to satisfy such requirements.

Terrestrial parks with marine components as well as provincial marine parks were considered and subtracted from the biophysical capability assessment.

Terrestrial parks with marine components as well as provincial marine parks were considered and subtracted from the biophysical capability assessment. Finally, through the Canadian Shellfish Sanitation Program, coastal areas are classified for safe commercial shellfish harvesting. Conversely, the program also identifies shellfish closure areas, which prohibit direct harvesting due to chemical or bacteriological contamination. Data on shellfish closures as of 12 September 2002 were provided by Environment Canada. These include both closures and conditional closures such as seasonal and rainfall limited areas. They do not include unclassified areas. Shellfish closure areas were also subtracted from the biophysical assessment.

Table 5-1. Data Themes and Sources for Capability Assessment

Data Theme	Source
Good or moderate biophysical capability	Ministry of Agriculture Fisheries and Food
Log boom tenures	Decision Support Services, MSRM
Finfish aquaculture tenures	Decision Support Services, MSRM
Shellfish aquaculture tenures	Decision Support Services, MSRM
Marine parks and terrestrial parks with marine components	Decision Support Services, MSRM
Shellfish harvesting closures	Environment Canada

Suitability refers to the degree to which the success of a shellfish operation may be modified by socio-economic factors.

Suitability

Suitability refers to the degree to which the success of a shellfish operation may be modified by socio-economic factors. These factors include transportation limitations, environmental values and potentially competing uses.

As was mentioned in Section 4.3, the distance that an aquaculture operation is located from its 'home port', or the point at which harvested product will be landed, is often the single most important factor in determining site suitability. Twenty nautical miles (~40 km) was determined to be a maximum travel distance between shellfish operations and a landing site. Therefore, a 20 nm buffer around the primary community in the territory was created and defined as the operational area. The buffer was calculated as a strict radius around the community and therefore may under-estimate distance over water and around islands and inlets.

Environmentally sensitive areas should be avoided when siting shellfish operations. As described in the following three documents: Shellfish Management Plan; Memorandum of Understanding between Lands and Water BC Inc. and provincial referral agencies; and Best Management Practices, minimum distance siting criteria are recommended for some environmental values. Environmental values included in the suitability analysis comprise estuaries, kelp beds, bird colonies, and seal and sealion haul out sites. Each of the environmental values was buffered according to prescribed guidelines (see Table 5-2). Due to lack of consistent coverage for the entire study area, environmental variables such as sensitive fish habitat, spawning streams, rocky reef habitats, clam and oyster beds, and whale feeding areas were not included in the analysis.

A proposed aquaculture operation should not negatively impact competing resource use and, conversely, shellfish operators should be aware of ongoing coastal activities.

A proposed aquaculture operation should not negatively impact competing resource use and, conversely, shellfish operators should be aware of ongoing coastal activities. Several types of coastal activities, were incorporated into the suitability analysis (the themes used depended primarily on their availability from DSS): commercial invertebrate fisheries for crabs; clams and prawns; and urchins; and recreational crab fishery. Foreshore and marine access may be limited by upland parks and candidate protected areas. Candidate protected areas, or areas of interest for inclusion in the Protected Ares Strategy, have been identified in several planning processes such as the Central Coast Land and Coastal Resource Management Plan and the North Coast Land Resource Management Plan. Finally, recreation is a key coastal activity in the north coast and there are many more coastal recreation opportunities available than are currently being used. A Recreation Features Inventory has been conducted for the province to identify existing and potential opportunities for a wide variety of recreational activities. Coastal activities including: beach combing, non-motorized boating, motorized boating, kayaking, sailing, scuba diving, sport fishing and shellfish harvesting were extracted from the inventory.

The presence of these activities in the vicinity of potential shellfish culture areas does not preclude development, and therefore are not subtracted from biophysical capability. However, shellfish operators should be aware of the extent of these activities and how they may impact shellfish operations and vice versa.

The suitability analysis has incorporated a range of potentially competing uses, which could influence the suitability of the site. However, the range of factors incorporated in the analysis is not exhaustive. Additional activities that should also be considered when exploring tenure sites include: anchorages; marinas; upland forestry development; and private land.

Table 5-2. Data Themes and Sources for Suitability Assessment.

Data Theme	Source
Operational area (20 nm radius around primary community)	AXYS Environmental Consulting Ltd.
Kelp beds	Decision Support Services, Ministry of Sustainable Resource Management (MSRM)
Eelgrass beds (100 m buffer)	Decision Support Services, MSRM
Sea bird colonies (500 m buffer)	Decision Support Services, MSRM
Seal and sealion haulout (500 m buffer)	Decision Support Services, MSRM
Commercial crab fishery	Decision Support Services, MSRM
Commercial prawn fishery	Decision Support Services, MSRM
Commercial crab fishery	Decision Support Services, MSRM
Commercial urchin fishery	Decision Support Services, MSRM
Recreational crab fishery	Decision Support Services, MSRM
Provincial parks with marine components	Decision Support Services, MSRM
Upland provincial parks	Decision Support Services, MSRM
Protected area strategy areas of interest from the North Coast LRMP	Decision Support Services, MSRM
Orders in Council protected areas from the Central Coastal Land and Coastal Resource Management Plan	Decision Support Services, MSRM
Beach combing activities and opportunities	Recreation Features Inventory, MSRM
Non-motorized boating activities and opportunities	Recreation Features Inventory, MSRM
Motorized boating activities and opportunities	Recreation Features Inventory, MSRM
Kayaking activities and opportunities	Recreation Features Inventory, MSRM
Sailing activities and opportunities	Recreation Features Inventory, MSRM
Scuba diving activities and opportunities	Recreation Features Inventory, MSRM
Sport fishing activities and opportunities	Recreation Features Inventory, MSRM
Shell fishing activities and opportunities	Recreation Features Inventory, MSRM

6.0 Food Safety and Shellfish Aquaculture

Table of Contents

6.1 Quality Assurance and Safety of Farmed Shellfish Products 2

- Importance of Growing Water Quality 2

6.2 Growing Water Classifications 4

6.3 Naturally Occurring Risks to Shellfish Safety 8

- Marine Biotoxins 8
- Marine Biotoxin Monitoring 9
- Vibrio parahaemolyticus 10

6.4 North Coast Water Quality & Biotoxin Program 11

- Background 11
- Program Overview 11

6.5 Regulatory and Licensing Requirements For Processing 13

- General Principles 13
- Registration and Certification of Processing Facilities 13
- Municipal Requirements 15
- Effluent Discharge Permits 15

6.1 QUALITY ASSURANCE AND SAFETY OF FARMED SHELLFISH PRODUCTS

Given that shellfish are often consumed whole, either raw or partially cooked, the water quality of shellfish growing areas has a direct impact on the potential health to consumers. Understanding and complying with issues, regulations and monitoring programs relating to product safety is critical to the development and success of a shellfish aquaculture industry.

Quality Assurance provides security to the end-user that the product is wholesome, meets high quality standards and is safe for consumption. To attain product Quality Assurance of Canadian shellfish, high measures of Quality Control techniques and verification processes are implemented at the plant and farm level. Shellfish growers in Canada are committed to ensuring that Quality Assurance and Quality Control (QA/QC) are principal components in their farming of shellfish.

For more information about shellfish quality and safety consult the Canadian Shellfish Quality Resource site at www.shellfishquality.ca

The Canadian Shellfish Sanitation Program (CSSP) is a comprehensive program that ensures the safety of shellfish by reducing the risk of public health hazards from the consumption of contaminated shellfish. The designation of safe growing waters, harvesting and shipping activities, and the processing of shellfish are highly regulated. The assurance that farmed shellfish are safe to eat and are of high quality are the two main considerations of the shellfish aquaculture industry. This program is administered jointly by the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada (DFO) and Environment Canada (EC).

Importance of Growing Water Quality

It is very important that Canadian shellfish come from monitored and approved water sources.

Bivalve shellfish are largely indiscriminate, immobile filter-feeders and they tend to reflect the chemical and biological quality of the growing water in which they live. Therefore, it is very important that Canadian shellfish come from monitored and approved water sources.

Potential Public Health Hazards

Shellfish that grow in proximity to sewage outfalls, marinas, or residences with poor sewage systems may accumulate viruses and bacteria that can cause human diseases. Diseases are spread by the ingestion of water or food that is contaminated with human fecal material or the feces of other warm-blooded animals. Other sources of bacterial or viral contamination are seal haul-outs, bird roosting areas and livestock.

Thorough cooking can destroy most disease organisms that accumulate in these filter-feeding animals. However, shellfish are usually eaten raw or slightly cooked. These methods will not allow for the harmful bacteria to be destroyed. In addition, several bacteria groups produce toxins that are only very slowly degraded by cooking, leaving heavily contaminated shellfish unsafe to consume.

Monitoring Pollution Sources

EC and the CFIA monitor growing waters for contamination. Through the monitoring programs they assure that shellfish come from pristine growing waters. The sources of contamination that can affect shellfish and for which they are monitored, include the following:

- ☐ Raw sewage from malfunctioning or improperly constructed domestic septic systems and tile fields;
- ☐ Urban and rural landwash containing organic wastes, pesticides, fertilizers, petroleum residues, metals or other pollutants;
- ☐ Direct discharges of raw sewage from boats and shoreside residences;
- ☐ Industrial discharges of metals, pesticides, chlorinated organic compounds or other pollutants;
- ☐ Direct discharges of raw sewage via municipal outfalls;
- ☐ Wildlife, domestic animals, congregations of marine mammals or birds and;
- ☐ Blooms of toxic phytoplankton species.

Pollutants are monitored due to their potential to cause acute health effects and delayed or chronic illness that may result from repeated ingestion of minute amounts. In addition, growers must exercise constant vigilance to avoid inadvertent contamination of shellstock during normal farm activities. Due to the sensitivity of shellfish to pollution and the potential for health hazards, the shellfish growing industry is focused on maintaining and promoting a clean environment with pristine water sources.

Due to the sensitivity of shellfish to pollution and the potential for health hazards, the shellfish growing industry is focused on maintaining and promoting a clean environment with pristine water sources.

6.2 GROWING WATER CLASSIFICATIONS

Marine waters from which bivalve are harvested or grown must be monitored, evaluated for pollution and classified in order for approved harvesting to take place. It is necessary that the water quality of shellfish growing areas be surveyed on a regular basis, and that actual and potential pollution be identified so as to minimize potential health risks associated with consuming shellfish.

Primary responsibility for these sanitary surveys rests with Environment Canada through the Canadian Shellfish Sanitation Program (CSSP). The designation of safe growing waters, the patrolling of shellfish harvesting areas, the harvesting, processing and distribution stages of the shellfish industry are all regulated by this program.

The sanitary quality assessment of growing areas identifies and evaluates those factors influencing the sanitary quality of the water. Shellfish growing water surveys can be divided into two components: bacteriological surveys and shoreline surveys. The former refers to the measurement of fecal coliform pollution indicators in the growing areas while the latter describes the studies required to identify and quantify possible pollution sources including movement, dilution, and dispersion of possible pollutants in shellfish growing areas. The primary objective of the surveys is to reduce bacterial contamination to protect consumers from potential threats associated with eating contaminated shellfish.
Following such surveys, the actual and potential growing areas are classified according to accepted water quality criteria and general sanitary conditions in the growing area. Depending on water quality and the results of the shoreline and sanitary surveys, several classifications are possible which permit or restrict varying degrees of harvesting.

Three general classifications are used in the C: Approved, Conditionally Approved and Closed. Each classification is related to the bacteriological quality of the growing water, the actual and potential sources of pollution and to some extent, the shellfish resource utilization of the area. [CSSP Manual of Operations Chap. 2.3; 1995]

GROWING AREA CLASSIFICATION	DESCRIPTION
APPROVED	**Shellfish growing areas may be designated as "Approved" if the following conditions are met:** a. *the area is not contaminated with fecal material, poisonous or deleterious substances or marine biotoxins to the extent that consumption of the shellfish might be hazardous; and* b. *the median or geometric mean fecal coliform Most Probable Number (MPN) of the water does not exceed 14/100 ml, and not more than 10% of the samples exceed a fecal coliform MPN of 42/100 ml, for a five-tube decimal dilution test.* [CSSP Manual of Operations Chap. 2.3.1; 1995] The sanitary survey indicates that sewage from adjacent communities would not reach this area in such concentration as to constitute a public health hazard, even under conditions which reflect the worst pollution conditions. Any evidence of potential pollution sources is sufficient to exclude the growing waters from the **Approved** category.
CONDITIONALLY APPROVED	**Shellfish growing areas may be designated as "Conditionally Approved" if the following conditions are met:** a. *during those times when harvesting is permitted, the area meets all of the requirements of an* ***"Approved"*** *area;* b. *conditions which preclude harvesting in areas designated* ***"Conditionally Approved"*** *must be:* i. *easily identified by routine measurement and reporting; and* ii. *predictable and/or controllable.* [CSSP Manual of Operations Chap. 2.3.2; 1995] During shellfish harvesting times, this area has the same sanitary quality as approved areas, however, the quality varies with: a. the effectiveness of sewage treatment for a community; b. rainfall or river flow; c. seasonal changes in sanitary conditions (i.e. tourist or summer cottage activity, vessel traffic, seasonal industrial operation) or some other predictable condition. During predicted periods of reduced sanitary quality the area is placed into a **Closed** status

CLOSED	**Shellfish growing areas are designated as "Closed" under any of the following conditions:** a. *the area is contaminated with fecal material, poisonous and deleterious substances to the extent that consumption of the shellfish might be hazardous;* b. *the median fecal coliform MPN of the water exceeds 14/100 ml, and/or more than 10% of the samples exceed a fecal coliform MPN of 43/100 ml, for a five-tube decimal dilution test; and/or the paralytic shellfish poison (PSP) concentration is = 80 µg/100 g and/or amnesic shellfish poisoning (ASP) concentration is = 20 µg/g of edible portion of raw shellfish meat, or other neurotoxic shellfish poison is found in detectable levels.* [CSSP Manual of Operations Chap. 2.3.3; 1995] Direct harvesting from this area is prohibited due to chemical or bacteriological contamination, and shellfish can be used only by permit under specified conditions for depuration, relaying, experimental purposes or other approved processing.
RESTRICTED FOR CONTROLLED PURIFICATION (THIS IS A SUB-CLASSIFICATION WITHIN THE **CLOSED** AREA CLASSIFICATION)	**An area that is Closed, however the following criteria have been met:** • *The median or geometric mean fecal coliform MPN of water does not exceed 88/100 ml and not more than 10% of the samples exceed a fecal coliform MPN of 260/100 ml, for a five-tube decimal dilution test.* [CSSP Manual of Operations Chap. 2.3.3.1; 1995] Areas in which harvesting is allowed for **Controlled Purification** will be specifically designated according to species-specific initial fecal coliform stock standards and the effectiveness of the purification process. All purification (depuration) takes place in waters which are designated **Approved**.

RESTRICTED FOR RELAYING (THIS IS A SUB-CLASSIFICATION WITHIN THE **CLOSED** AREA CLASSIFICATION)	**An area that is Closed, however the following criteria have been met:** • *The median fecal coliform MPN of the water exceeds 14/100 ml, and/or more than 10% of the samples exceed a fecal coliform MPN of 43/100 m, for a five-tube decimal dilution test. These areas must not be in a Prohibited area (see below).* [CSSP Manual of Operations Chap. 2.3.3.2; 1995] The shellfish must be held in **Approved** area waters for a sufficient time and under adequate environmental conditions to allow purification to occur. This period shall be at least 14 consecutive days when environmental conditions are suitable for purification unless shorter periods are demonstrated to be adequate.
PROHIBITED (THIS IS A SUB-CLASSIFICATION WITHIN THE **CLOSED** AREA CLASSIFICATION)	**An area that is Closed, however the following criteria have been met:** *Distinct areas or areas within* ***Closed*** *growing areas that are prohibited to shellfish harvesting for any purposes. These areas include:* a. *a minimum or 300 m closure in the immediate vicinity of major point source discharges such as sewage and outfalls;* b. *within 125 m (minimum) of certain permanent or floating structures which may be the source of contamination. Such structures are defined as follows:* i. *any wharf, dock, platform or floating structure used for vessel moorage; or* ii. *including float homes, barges, platforms and vessels used for accommodation, fish processing or any other purposes; and* c. *areas where due to the degree of contamination in the growing waters (i.e. waters having excessive concentrations of poisonous or deleterious substances), it may not be possible to adequately depurate or naturally purify the shellfish.* [CSSP Manual of Operations Chap. 2.3.3.3; 1995]

6.3 NATURALLY OCCURRING RISKS TO SHELLFISH SAFETY

Marine Biotoxins

The sources of marine biotoxins have been commonly associated with toxic algal blooms of dinoflagellates. Filter-feeding bivalves that graze on natural phytoplankton populations are prone to accumulation of marine biotoxins naturally produced by these algae.

Shellfish toxicity and its association with exceptional blooms of phytoplankton, or Harmful Algal Blooms (HABs) pose serious problems to harvesters, seafood processors, consumers and regulatory agencies. For the Pacific Coast, the seasonal conditions for HABS happen most commonly in the spring and fall; specifically the months of May through October are more prone to toxic algal blooms.

However, long-term retention of these toxins by shellfish may result in the occurrence of toxic shellfish at any time of the year. Ingesting the biotoxin contaminated shellfish can cause the following diseases, named after their most notable symptom:

- Paralytic Shellfish Poisoning (PSP)
- Amnesic Shellfish Poisoning (ASP), and
- Diarrhetic Shellfish Poisoning (DSP)

It is important to note that most species of algae or phytoplankton are not harmful and do not produce these toxins. Not all reddish plankton blooms are toxic and some toxic blooms are either invisible or green.

It is important to note that most species of algae or phytoplankton are not harmful and do not produce these toxins. Not all reddish plankton blooms are toxic and some toxic blooms are either invisible or green.

Paralytic Shellfish Poisoning

Paralytic shellfish poisoning (PSP) toxins acquired from marine dinoflagellates are a suite of potent, water-souble neurtoxins, known as saxitoxins. As PSP toxins are released after digestion of toxic cells in the viscera, the digestive system is found to contain the highest toxicity levels. The PSP toxins are sodium channel blocking agents in nerve and muscle fibers. The most common symptoms associated with PSP in humans ranges from the tingling of the tongue and lips to vomiting, pain, diarrhea, loss of coordination and difficulty of breathing. Human fatalities resulting from consumption of toxic shellfish are caused by respiratory paralysis.

Amnesic Shellfish Poisoning

Amnesic Shellfish Poisoning (ASP), is caused by domoic acid, which is a metabolic product of a marine or brackish water diatom (*Nitzschia pungens*). Domoic acid is of similar molecular size and shape to the common and beneficial amino acid, glutamic acid. It disrupts normal neurochemical transmission in the brain by binding to glutamate receptors causing neurons to fire continuously until the cell ruptures. The results are lesions or damaged areas of brain tissue,these effects can be permanent. Symptoms include abdominal cramps, neurologic responses involving memory loss and disorientation.

Diarrhetic Shellfish Poisoning

Diarrhetic Shellfish Poisoning (DSP) is produced by okadaic acid, which has been associated with certain dinoflagellates. The symptoms of DSP include stomach pain, vomiting and diarrhea and is easily confused with gastroenteritis or general stomach upsets associated with eating shellfish or contaminated shellfish. It is often a short-lived and non life-threatening occurrence.

Marine Biotoxin Monitoring

The Canadian Food Inspection Agency (CFIA) provides a biotoxin monitoring program in shellfish growing areas

The CFIA provides a biotoxin monitoring program in shellfish growing areas with the assistance of the DFO, which enforces and implements of the program.

The monitoring program involves mussel-monitoring stations at key locations and verification sampling of commercial products at processing plants. Mussel monitoring stations are established at specific locations that represent where commercial and recreational harvesting take place. The samples are shipped to the CFIA Fish Inspection Laboratory.

Mussels are used because they are considerably faster and more efficient in accumulating marine biotoxins. This increased sensitivity of mussels to marine biotoxin accumulation alerts the monitoring program of possible contamination before toxicity levels rise in commercial species.

A closure is immediately implemented if high toxicity levels are detected. A closure for the contaminated area remains until the biotoxin levels of the mussels decrease below cautioned levels and a time interval, sufficient in length to permit the natural biological cleansing of the shellfish has elapsed.

Vibrio parahaemolyticus

Vibrio parahaemolyticus (*Vp*) is a naturally occurring marine bacterium known to exist in waters of the Pacific Coast and is often associated with food poisoning incidences relating to seafood products. Both pathogenic and non-pathogenic forms of the organism have been isolated from marine and estuarine environments and from fish and shellfish dwelling in these environments.

Warm summer temperatures and estuarine conditions (reduced ocean salinity) are favourable growth conditions for this species. *Vp* has a remarkable capacity for growth and moderate levels of bacteria (100s/g) can increase to high levels in as short as 2-3 hours if products reach 20-35 ° C.

Raw, mishandled, improperly stored or cross contaminated cooled seafood are generally the source of illness with shrimp, crab, lobster and oysters producing the most incidences in North America. This bacterium is unable to grow at temperatures below 12° C and is easily destroyed by cooking seafood to more than 65° C (145°F). Cooked seafood should be eaten within 2 hours of preparation or promptly chilled to less than 5° C and held in refrigeration.

Consumption of large numbers of *Vp* causes gastroenteritis. Symptoms may be severe and include nausea, diarrhea and in some individuals abdominal cramps and fever. The incubation period from consumption to illness may range between 4 to 96 hours and recovery may take as long as a week.

_Vp_ Management

Environmental monitoring of *Vp* levels indicate a high-risk period in the months of July and August. Because of its rapid growth rate, temperature control of products to prevent contamination and growth of the bacteria is critical to product safety.

A *Vp* **Risk Reduction Strategy** (RRS) has been developed to prevent outbreaks of *Vp* associated with consumption of raw oysters. As part of the *Vp* RRS, CFIA initiated a monitoring program of BC oysters in 1997, which included proper control of oyster temperatures from harvest, prompt reporting, investigation of illnesses, a communications strategy,a tiered action plan that addressed *Vp* levels, illnesses and time of year. The program now runs from May – September every year. Participation in the program is mandatory for growers who wish to maintain osyter sales during July and August, as CFIA requires all shellfish processors to implement *Vp* controls at the harvest site.

6.4 NORTH COAST WATER QUALITY & BIOTOXIN PROGRAM

Background

In most other regions of Canada, biotoxin and water the federal government conducts quality testing regularly. However, such testing has been very sporadic on the North Coast in recent decades due to a combination of factors such as the remote nature of the area and the high costs involved in monitoring and testing. Consequently, one-third of BC's coastline remained permanently closed for most shellfish activity for almost 40 years. This closure impacted both recreational harvesting and First Nation traditional harvesting, and it has precluded the development of a shellfish farming industry on the North Coast.

Program Overview

The **North Coast Water Quality & Biotoxin Program**, based in Prince Rupert, coordinates biotoxin and water quality monitoring and testing services for shellfish harvesting and growing interests on the North Coast mainland and Queen Charlotte Islands.

It is a non-governmental association that consists of representatives from local First Nations and non-First Nations communities, shellfish farmers, scientists, economic development groups, and local, provincial and federal government. Coastal British Columbia has endemic Paralytic Shellfish Poisoning (PSP) blooms that are of particular concern to local First Nations who harvest shellfish regularly as part of their traditional heritage. Monitoring stations tend to be very remote, so the North Coast Water Quality & Biotoxin Program faces a complex set of challenges.

North Coast Water Quality & Biotoxin Program

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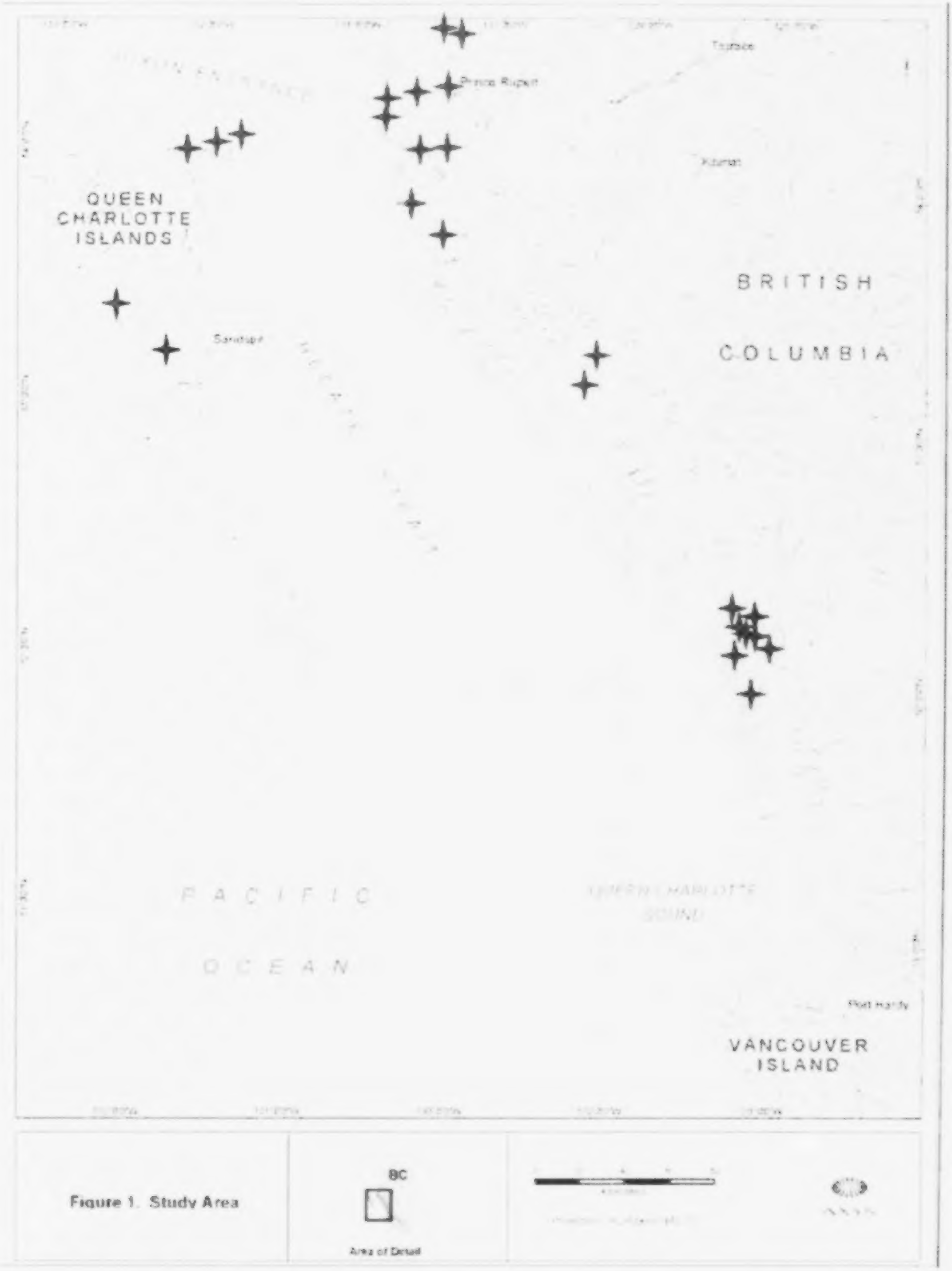
Phone: (250) 627-5135
Fax: (250) 627-5139

Website:
http://www.predc.com/north/coast/biotoxin.htm

BIOTOXIN PROGRAM


Terrace
Prince Rupert
Kitimat
QUEEN CHARLOTTE ISLANDS
Sandspit
BRITISH COLUMBIA
PACIFIC OCEAN
QUEEN CHARLOTTE SOUND
Port Hardy
VANCOUVER ISLAND
Figure 1. Study Area
BC
Area of Detail

North Coast Marine Biotoxin Monitoring Stations ***(Source CFIA)***

6.5 REGULATORY AND LICENSING REQUIREMENTS FOR PROCESSING

General Principles

Bivalve shellfish may only be sold to, or processed in, a federally and provincially certified and registered facility. Those registered facilities are in good standing with the CFIA and meet all of the requirements of the Fish Inspection Regulations. This includes the requirements to have an acceptable Quality Management Program in operation, which is described in more detail below.

Canadian Food Inspection Agency Website:http://www.inspection.gc.ca

United States Food and Drug Administration – NSSP Model Ordinance

http://www.issc.org/documents/Model-Ordinance-1999/MO-1999-Table-of-Contents.pdf

Registration and Certification of Processing Facilities

The necessary step of ensuring that all harvested shellfish pass through an inspected facility, provides an important safeguard to the public that product has been inspected and handled according to quality assurance requirements. All federally registered fish processing establishments must comply with Schedules I and II of the *Fish Inspection Regulations*. The overall intent of Schedules I and II is to provide physical environment and operational requirements that will facilitate a sanitary processing operation and be conducive to the production of safe and wholesome fish products. The design, layout and construction of fish processing establishments, the nature and condition of equipment and materials that they use and sanitary conditions are all important factors in ensuring that only safe and wholesome fish products are produced in Canada.

Seafood processing facilities only require provincial registration, if theysell product in BC only. Facilities which handle bivalve shellfish must however, be federally registered, regardless of where products are going to be sold.

Facilities which plan to sell product only in Canada require compliance with the CSSP guidelines and regulations. In order to export shellfish (shucked or live) into the United States, plants must conform to the National Shellfish Sanitation Program (NSSP) guidelines and regulations. NSSP approved plants are placed on the US Interstate Certified Shippers List. This identifies those companies which may import into the US and ship across state lines. Companies planning to sell into other foreign markets should also anticipate additional requirements required by other countries of export. Most notable is Europe, which has separate requirements for selling into the European Economic Community (EEC). Japan also has specific regulatory requirements for shipping oysters into their market.

Quality Management Program

The **Quality Management Program (QMP)** is a regulatory-based system that requires all federally registered fish processing plants in Canada to develop and implement an in-plant quality control program. As set out in the *Fish Inspection Regulations*, all establishments in Canada that process fish and seafood for export or inter-provincial trade must be registered with the Government of Canada. To become federally registered, a fish processor is legally required to develop a QMP plan of their own, following the "QMP Reference Standard." They must submit it to the CFIA for review and acceptance and apply it to their processing operations.

The QMP uses the principles of HACCP (Hazard Analysis Critical Control Point), an internationally recognized system for ensuring safe food production

The QMP uses the principles of Hazard Analysis Critical Contol Point (HACCP), an internationally recognized system for ensuring safe food production, in order to provide a high level of assurance that fish and seafood products produced in Canada are safe to eat. However, the QMP also deals with non-safety issues, including fish quality and federal regulatory requirements such as labelling.

The QMP was established as a mandatory program in 1992, making it the first mandatory food inspection program in the world based on HACCP principles. Prior to this, fish inspection was conducted as a traditional food inspection program, with federal inspectors inspecting fish plants and testing their products. The QMP was extensively re-engineered between 1996 and 2000. The QMP requires processors to monitor their own compliance with regulatory requirements and identify and correct problems quickly, should they occur.

Along with promoting the production of safe and wholesome fish/seafood products and thereby protecting

Canadian consumers, the QMP benefits fish processors in a number of ways. These include a streamlined process for the certification of final products for export; the privilege of using the "Canada Inspected" logo on their products;a minimization of government intrusion and intervention in their day-to-day operations. Because it incorporates the application of HACCP principles, the QMP has also been effective in maintaining access to international markets, at a time when many countries are introducing HACCP requirements for imported fish and seafood. This is important for Canada's seafood processing industry, which is heavily export-oriented: almost 90% of the fish and seafood products produced in Canada are exported.

Municipal Requirements

Individual municipalities and/or Regional Districts should be contacted for local requirements pertaining to zoning bylaws, building construction permits, inspection and health requirements, etc.

Effluent Discharge Permits

Facilities which will discharge effluent waste into the environment require approval and waste management permits from regional waste management offices of the Ministry of Water, Land and Air Protection. Waste Management permits authorizes the discharge of wastes to the environment and set limits on the quantity and quality of the discharge. They also set requirements for monitoring the effect of the discharge on the environment and any other terms and conditions, which may be necessary to prevent pollution. The terms and conditions set out in the permits are legal requirements.

7.0 Shellfish Aquaculture Marketing Overview

Table of Contents

7.1 Introduction 2

7.2 Shellfish Consumption Trends 2

7.3 Current Market Environment by Species 5

- Half Shell Oysters 5
- Shuck Oyster Situation 6
- Mussels 7
- Manila Clams 9
- Scallops 9
- Abalone 10
- Green Sea Urchins 10
- Kelp 11
- Geoduck 11
- Cockles 11

7.4 Current Market Environment by Country 11

- United States 12
- Japan 12
- China 13
- Hong Kong 14

7.5 Future Outlook and Potential 15

7.6 Processing 16

7.7 Distribution 16

7.8 Transportation 17

7.9 Generic Marketing 17

7.10 Marketing Recommendations 21

- Marketing Plan 21
- Value Added 22
- Regional Branding 22
- Product Quality 22

7.1 INTRODUCTION

Shellfish aquaculture is an industry, which by its very nature has several potential marketing advantages. The managed and controlled farming of shellfish products offers the ability to produce a consistent, premium quality product. The final product can be harvested and processed in an orderly fashion into premium product forms. With this high level of control, the shellfish aquaculture industry has the potential to obtain maximum benefits from the resource. However, to secure maximum returns, the industry must actively market its product.

Consumer Demand

A complete understanding of consumer demand and the current marketing environment must precede any production decision. The question of what the consumer wants, now and in the future, is the first question that must be asked. One of the main reasons shellfish aquaculture projects fail is they are often production, rather than market driven.

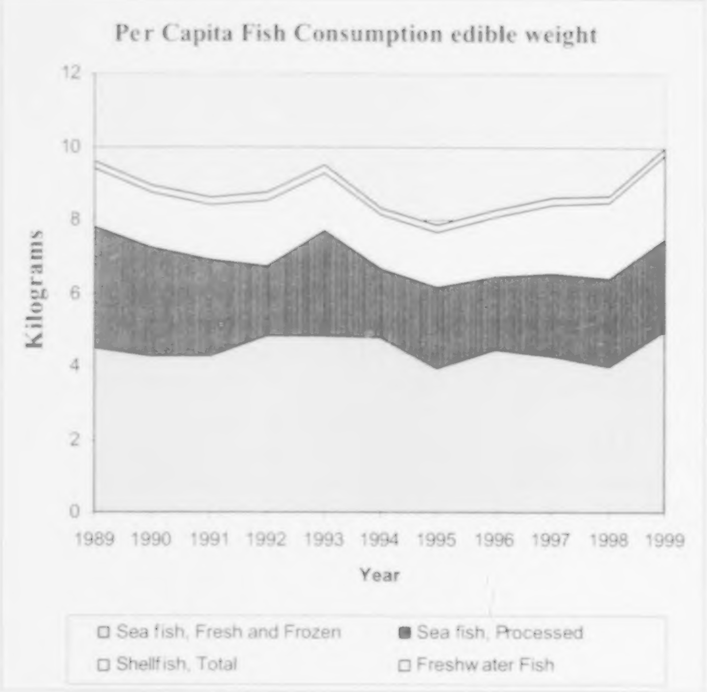
7.2 SHELLFISH CONSUMPTION TRENDS

World demand for shellfish and other seafood is steadily increasing at a time when all traditional wild harvest fisheries are on the decline. One of the reasons that there is such a strong economic potential of shellfish aquaculture in BC is because of the growing market demand for shellfish products.

Over the past 10 years, shellfish consumption has accounted for the majority of the increase in per capita consumption of seafood in Canada.

Per capita, consumption of all seafood products around the world has been increasing over the last two decades. However, over the past 10 years, shellfish consumption has accounted for the majority of the increase in per capita consumption of seafood in Canada. In both Canada and the US, consumption is generally highest in urban centers.

Figure 23. Per capita fish consumption in Canada 1989 – 1999 by type.
(Source: Statistics Canada).



Canada is not the only region experiencing a general trend of increased seafood consumption. Dietary habits are changing worldwide, especially in developed European countries. Markets have become more flexible and new products and species have found market niches. Increased value added fish and shellfish products are anticipated to increase.

Europe is currently the largest consumer of mussels. The French per-capita consumption stands at 1.6 kg per person, which is over 50 times that of American consumption levels. Canadian mussel consumption is approximately 0.27 kg per person.[1]

Zimet and Smith (2000)[2], conducted a survey of oyster consumption and purchasing habits. They found that:

- 15% of the US population consumes about 85% of all oysters sold
- The average oyster consumer is male, between the ages of 18-49, lives in a coastal area and earns $60K plus in income

The market for oysters on the half-shell has expanded recently in the US and imports of oysters have climbed steadily since 1990

Oysters rank #8 as best selling seafood in US

(Coopers and Lybrand, 1997). In 1999, the overall top ten list of best selling seafood species in the US, as reported by Seafood Business magazine, showed oysters to be number eight.

Demographically, it is the older segment of the population that is the primary purchaser of most seafood, including shucked oysters. However, consumption of half-shell oysters is currently heaviest in the 18-49 year old group. It is anticipated that securing younger consumers will require product diversification, innovative packaging and positioning and a focus on development of ready to eat products (Ecotrust Canada, 2002).

Other consumer trends noted in a recent shellfish market survey conducted by Ecotrust Canada (2002) were:

- ☐ Clams, scallops, and mussels appear to remain on a growth curve in the marketplace.
- ☐ Issues around product safety and sustainability will continue to grow in importance and become important selling tools.
- ☐ Flow of product across borders will probably become more difficult, with increased regulations around food supply safety given the heightened global concern around terrorism.
- ☐ New technology that kills bacteria and extends shelf life will continue to emerge and provide a competitive edge in the marketplace.

While the US is a huge market for Canadian seafood, the potential would be even greater if the per capita consumption levels in the US would rise. Americans eat a fraction of the per capita consumption of other countries (14.8 pounds per capita). In Canada, consumption of seafood was over 50 pounds per capita between 1997 – 1999. In the UK, seafood consumption averaged around 40 pounds per capita for the same period.

There are many theories put forward by experts to explain why the per capita seafood consumption in the US is so low. Most agree that US seafood consumers are given a barrage of mixed messages about health, sustainability and supply. In addition, the recession and September 11th have reduced the amount that Americans are eating out in restaurants. This is a significant issue as more than 70% of seafood is eaten in restaurants in the US.

Of the US seafood imports in 2001, 84% were either fresh or frozen – up from 83% in 2000. (Intrafish, 2002). The demand for frozen seafood reflects a growing trend in the category. This is partially due to the consumer's changing food preparation behavior. As time pressures have increased, people are less willing to spend time cooking. Easy food preparation is a key factor in consumer choices. This shift in dietary habits is not only occurring in the US, but is being seen worldwide.

Frozen product offers many advantages for shellfish aquaculture on the Central and North Coast.

Given the growing market trend to frozen seafood products and the logistical advantages of supplying frozen product, it is strongly recommended that frozen, rather than fresh product forms be chosen in the Central and North Coast.

Price

Rising incomes, population growth, a growing demand for seafood and limited supplies were major reasons explaining significant increases in prices during the past 20 years. These factors should continue to keep cultured shellfish prices at high levels during the next decade (Coopers and Lybrand, 1997).

7.3 CURRENT MARKET ENVIRONMENT BY SPECIES

Oysters, Mussels, Scallops & Clams recommended for culture

The choice of species for shellfish aquaculture development is a complicated mix of product marketability and biological characteristics, matched with the availability of suitable sites and technology. After evaluating these factors, oysters, mussels, scallops and clams are being recommended for culture - the market information for each species is provided below:

Half Shell Oysters

In 2000, the value of BC oyster and clam exports both registered double-digit increases. Oyster exports rose 14% to $8.2 million and clam exports rose by 17% to $6.6 million. Oyster exports have risen for three consecutive years, increasing 39% during this period. The majority of oyster exports go either to the United States or Hong Kong.

The market for live oysters is currently very strong in the Pacific North-West. One of the larger oyster producers in Washington State indicates that the company's live sales now outnumber shucked meat sales by a ratio of 3 to 1. Just less than 10 years ago, the ratio was reversed.[3]

Shuck Oyster Situation

Traditionally, there has been a chronic shortage of shucked oyster farm production and this trend has shifted.

Traditionally, there has been a chronic shortage of shucked oyster production on Vancouver Island, with processing and market capacity outpacing farm production.

This trend has shifted for three reasons:

- ❑ A current soft market due to increased production in BC and the rest of North America
- ❑ Lack of aggressively pursuing market growth and
- ❑ Processors unwilling to process the available shuck production on Vancouver Island.

The weak market for shucked product is much broader than just Vancouver Island – it is being experienced throughout the entire Pacific Coast. According to processors, the industry is partially to blame as there has been little effort done to promote the product.[4]

Oysters - Market Recommendations

The existing oyster industry in BC has developed based on the almost exclusive sale of fresh oysters to export markets. If new business ventures in the Central and North Coast choose a similar approach, they will automatically face competitive disadvantages, particularly in transportation costs and logistics.

Following are the recommended product forms for production/processing of oysters:

1. Individual quick frozen (IQF) half shell, either Top Valve Off (TVO) or whole can be glazed during process to further enhance quality.
2. TVO value added (i.e. Oyster Rockefeller)
3. Shucked oysters (preferably value added, requiring minimum processed volume shipped)
4. High value single oysters for niche markets. This is a small market - due to transportation and shelf life issues, this market will not contribute to high volumes.

Mussels

The mussel industry in BC and Canada is considered a growth industry. Sales are not only strong, but they are expected to increase over the next 3-4 years.

The largest markets for mussels are found in Europe and North America. About half the Canadian mussel supply is sold fresh in shell, with the balance divided almost equally between frozen meat and canned products.

The US market for fresh and frozen mussels has experienced strong growth throughout the 1990's, growing from 5,754 tonnes in 1990 to 13,688 tonnes in 1997. Over this period, the US market has become more dependent upon imported mussels, with imports increasing from 2,643 tonnes (46.1% of total supply) in 1990 to 12,204 tonnes (89.2% of the total mussel supply) in 1997. Canada is the dominant player in the US fresh mussel market, which is centered primarily in the Northeastern US. In fact, PEI accounts for more than 90% of the US supply of rope-grown live mussels, while New Zealand has traditionally been the dominant supplier of the value added market segment. Through May 2002, US imports of frozen Greenlipped mussels on the half shell were up almost 50%, to 5,700 metric tons.[5]

However, whole frozen cooked blue mussels from Chile and China are also finding markets in the US. Through June 2002, imports of frozen Blue mussels from Chile tripled to 171 metric tons (mt).[6]

Canadian mussel production is almost entirely sold within North America (56% stays in Canada; 44% sold to US). In 1997, 78% of the Canadian mussel market was supplied by domestic production. Due to anticipated mussel consumption increases in Canada, there is room for increased production and sale of Canadian mussels within Canada.

The remaining 22% of Canadian sales are frozen, value added products from New Zealand. With total consumption showing growth in this sector (increase of more than 3,843 tonnes in 1990 to 8,323 tonnes in 1997), there is an opportunity to launch a high quality value added Canadian mussel product that could compete with the New Zealand imports.

Mussels – Supply Outlook

It is anticipated that production of mussels from PEI in 2002 could reach 16,000 mt, almost double the harvests of five years ago and an increase of about 10% from 2001. However, long term production growth from PEI is anticipated to slow down to sustainable levels of about 10-15 % a year. Most of the growth in Canadian mussel production is coming from Newfoundland, where production was up 38% in 2001.

Mussel production can be expected to increase in BC, as many BC producers are currently adding Mediterranean mussels to diversify their product line. Taylor Shellfish Co., the largest shellfish farming company in Washington State, also plans to expand its production of Mediterranean mussels in BC. Continued supply of frozen, whole Blue mussels from Chile and China are also expected to meet the demand of this growing market segment.[7]

Mussels - Market Recommendations

Central and North Coast production could help fill demand for fresh and frozen mussels in Western Canada and US

There is an opportunity for Central and North Coast production to help fill the growing demand for fresh and frozen mussels, particularly in major centres in Western Canada and the US. Given that one-fifth of the US population resides in the Wwestern Sstates (Alaska, Washington, Oregon, California, Nevada, Arizona, Utah and Idaho), this market could be of significant importance.

Following are the recommended forms of mussels for production/processing:

- Limited fresh market
- Individual quick frozen (IQF) either Top Valve Off (TVO) or whole. Can be glazed during process to further enhance quality. Excellent with Ggallo mussels.
- Mussels partially cooked and presented in a prepared sauce or their own juices, and then blast frozen in a vacuum package. Mussels marinara and mussels in a white wine sauce are examples of possible variations.

Manila Clams

Export statistics are available for BC farmed oysters, but not separately for farmed clams. In 2000, the value of oyster and clam exports both registered double-digit increases. Clam exports rose by 17% to $6.6 million, the majority of which were exported to the US market. Canada is the largest exporter of fresh and frozen clams to the US.

Fresh clams are sold primarily to the restaurant trade. Prices for farmed clams tend to be higher than the prices for the wild product. This has been attributed to several factors including greater inventory, quality control and a high level of integration between primary production and processing.

Manila Clams – Market Recommendations

Due to high demand, the fresh market is the only significant product form for farmed clams.

Scallops

Scallops are usually highly regarded and command high prices in both the domestic and export markets.

For Canadian producers, both of wild and cultured products, the US is the principal market, taking 90% of the production. Through the wild fishery, Canada is the dominant supplier of premium, fresh scallops in the US market, but a rather small contributor to the country's frozen scallop market.

In general, the market can be divided into two major segments: meats only and whole scallops in the shell. The market for meats is very large and well established, while the whole scallop segment is small and not well defined. While whole scallops do not constitute a large segment of the market, the potential for the whole scallop is very promising. Prices for whole scallops are much higher than for meats alone. Limited supply coupled with good economic conditions in the US has provided for excellent price levels.

There is a strong future potential for BC to supply farmed scallops to US market

With imports of Chinese scallops into the US declining over the past three years, there is a strong future potential for BC to supply farmed scallops to the US market.

Scallops – Market Recommendations

The traditional market for scallops is as shucked meats, which may be sold fresh or frozen. While this option is open to scallop farmers, it would result in direct competition for markets with the commercial fishery and may be vulnerable to price fluctuations.

An option is to sell live scallops in the shell, at a smaller size than would normally be harvested for meat. Development of this segment however, is constrained by the short shelf life of the product. Scallops do not survive as well out of water as do oysters or mussels therefore, market distribution lines must be very short.

Following are the possible market forms for scallops:

1. Scallop meats, either frozen or fresh
2. Whole live scallops in the shell. Given previous discussion regarding short shelf life and PSP issues, this is not a strongly recommended option.

Abalone

The world production of cultured abalone has grown rapidly, with China leading production. Recent prices for some abalone products have included US$49 per kilogram for live abalone in the shell, US$66 per kilogram for fresh processed abalone, US$45 per kilogram for frozen abalone and US$80 per kilogram for canned abalone.

While market demand is high, market research and distribution channels would need to be explored prior to development of a business plan.

Green Sea Urchins

The wild fisheries have been the only source of sea urchins to date. With resource depletion in many areas, attention has turned to the culture of sea urchins. Sea urchin roe is a product primarily sold in Japan and other Asian countries. The roe is considered a premium product in Asia. In the 1990's, prices for the roe were high in Japan. However, the market and its prices are subject to fluctuations.

While market demand is high, market research and distribution channels would need to be explored prior to development of a business plan.

Kelp

For the most part, kelp is cultivated for human consumption, although seaweed is also processed for use in animal feeds, fertilizers, soil additives and medicines. Prices for seaweed vary, depending on the end use for which they are intended. A large established market for seaweed products exists and premium products in select markets are capable of commanding high prices.

While market demand is high, market research and distribution channels would need to be explored prior to development of a business plan.

Geoduck

The geoduck clam is the highest value clam with strong export market potential. The majority of Canada's geoduck is sold to Hong Kong and China. In fact, geoduck was the highest value export from BC to Hong Kong in 1999. In 2000, 1,101 tonnes of live geoducks were sold to Hong Kong for a value of $32.5 million or $29.52 per kilogram.

Cockles

The cockle is an indigenous species to BC with importance to traditional First Nation harvesting. The species is common in Europe and may have some appeal to the Asian market place.

Extensive market research and distribution channels would need to be explored prior to development of a business plan for cockles.

Approximately 80% of BC's shellfish aquaculture products are exported with the primary export markets being the US and the Pacific Rim.

7.4 CURRENT MARKET ENVIRONMENT BY COUNTRY

The shellfish aquaculture industry export oriented. Approximately 80% of BC's shellfish aquaculture products are exported with the primary export markets being the US and the Pacific Rim. These markets have been explored below, given they provide the greatest potential for BC shellfish aquaculture products from the Central and North Coast.

United States

The US economy has been particularly strong and consumption of shellfish continues to increase. The markets in BC and the US are basically the same, with similar channels for flow of product and similar trends in the marketplace.

Continued demand from the US for high quality fresh seafood will continue to fuel growth in Canada's aquaculture production. Since the US has somewhat limited ability to expand their production (due to legislative and regulatory barriers) BC/Canada is therefore in an excellent position to expand production to fill the ever-increasing demand for seafood in the US.[8]

Almost half of the fresh and frozen seafood eaten by US consumers is now farmed. Of the top aquaculture species consumed in the US oysters, mussels and Manila clams rank in the top ten. US consumers are increasingly looking outside their borders to supply their seafood needs. Of the total US seafood supply, more than 80% is imported ($9.9 billion). Live oyster imports rose from 3.5 million pounds in 1995 to 6.3 million pounds in 2000 - approximately 2/3 of these oysters came from Canada. Processed oyster import volumes have been relatively stable over the past 10 years, totaling 27.3 million pounds in 2000.

Japan

Japan remains a vast, untapped market for Canadian seafood

Japan is Canada's second largest foreign market for agri-food (22% of total fish exports) products after the US. While Canadian trade with Japan has expanded during the past decade, the increase has been scarcely sufficient to keep pace with the rate of growth in Japanese imports. At 4%, Canada's share of the seafood market has been heading slightly downward in recent years. For Canadian seafood exporters, Japan still remains a vast, untapped market.

However, over the last few years the consumption of seafood products in Japan has been strongly influenced by their economic crisis. The economic recession and the subsequent low value of the Yen led to a decline in imports and consumption in 1998. In 1999, the Japanese economy started to recover, but not as quickly as originally forecast because it was found that Japanese consumers were not spending as freely as they had done before the crisis. Food items that consumers consider to be expensive have had difficulty in regaining their pre-crisis market shares.

China

Canadian finfish and shellfish are popular in the China market, especially in South China. Exports of Canadian fish and seafood (particularly live or frozen) to China remain buoyant at both the food service and retail levels. Beyond lobster and salmon, there is now greater demand for a diversified product mix including oysters, crab, clams, mussels, freshwater fish and other premium products. China's seafood consumption is increasing and is projected to grow by 4 to 6% per annum over the next few years. Generally, environmental concerns mean that import growth rates for seafood exceed those for meat.

China imported $2 billion of fishery and aquaculture products in 2001, which is nearly triple since 1987. It is expected that Chinese seafood imports will continue to increase at a significant rate – this vast potential will grow as long as living standards of the Chinese people increase. Currently, the market is primarily located in the coastal cities of China where consumers tend to have more disposable income and are more familiar with a wide variety of seafood products. Many Canadian seafood products are targeted to the high-end premium market of the affluent and middle class consumers with increasing incomes.

After arriving at the ports, frozen seafood products are shipped via China's railway and highway transportation network to the various cities for sale. The distribution chain is as follows: the primary importers sell to local first-level wholesalers, who then transfer product to dealers, who in turn sell to retailers. The main retail venues for seafood in China are the wet markets and food stores. In addition to frozen seafood, there is a smaller but substantial market for live seafood in China. Live seafood products are shipped by air and the main point of entry is Beijing. The many live seafood products entering China are:

There are significant challenges in doing business in China including a lack of transparency in business matters and poorly developed credit and payment mechanisms requiring extensive supplier credits

crab, oysters, lobster and geoduck.

However, there are significant challenges in doing business in China, including a lack of transparency in business matters, poorly developed credit and payment mechanisms requiring extensive supplier credits. A lack of consistency and transparency around tariffs, technical procedures (labelling, packaging, regulations specific to quality, etc.) and other rules of entry add a degree of difficulty to the trading process.

China is attempting to be self-sufficient in food products. As a result, markets are often characterized by high entry costs and low trading margins. In order to succeed, proper export readiness, consistent follow-up, relationship building and a great deal of patience are necessary.

Canada faces stiff competition from third-country suppliers such as the US, Australia, New Zealand and the European Union. The US and Australia are well established in some areas, but only after years of investment by national companies and industry associations. To be successful in China, Canadian suppliers must be aggressive and innovative to give customers reason to displace existing foreign products.

Hong Kong

Opportunities for BC farmed shellfish in Hong Kong include geoduck clams, mussels and jumbo oysters.

Seafood products are still in high demand in Hong Kong. In response to the recent financial turmoil however, consumers are shifting to lower-priced products. Unfortunately, due to the higher freight charges for shipping products from Canada to Hong Kong, Canadian products are frequently higher priced than local products. However, food safety scares have created a potential opportunity for high quality Canadian farmed seafood in the high-end restaurant market.

In addition, Hong Kong's recent imposition of the 2 parts per million (ppm) cadmium level has also significantly affected the ability to export BC oysters into this market.

As a free market, Hong Kong is one of the most competitive economies in Asia. Goods from all over the world enter Hong Kong duty free, and are readily available. Food products therefore, require strong, ongoing and consistent support in order to win market share. The US, Australia, New Zealand and the European Union are very active and well entrenched in the market. Canadian suppliers must be able to exhibit their quality and price advantages over these competitors. In addition, Hong Kong's recent imposition of the 2 parts per million (ppm) cadmium level has also significantly affected the ability to export BC oysters into this market.

Opportunities for Canadian farmed seafood products in Hong Kong include geoduck clams, mussels and oysters (particularly jumbo Pacific oysters).

7.5 FUTURE OUTLOOK AND POTENTIAL

In the recent past, BC's farmed shellfish supply has been only a small fraction of demand and processors have been able to easily sell all they could source. However, industry is now in a major transition period. Provincial and North American production of oysters has increased, creating soft markets and making it apparent that traditional market channels need to be expanded and new channels developed. However, while all information sources indicate that potential new markets do exist for BC shellfish, many of those opportunities require a much larger critical mass in order to successfully supply on a consistent, year round basis.

New markets for BC shellfish require a larger, critical mass

It is anticipated that the seafood consumer of the future will be older, better educated, health conscious and more demanding. By all accounts, it is predicted that the demand for exclusive processed shellfish products will grow quicker than the demand for products that are more of a raw 'unprocessed' nature.

Clearly, aquaculture as a whole plays a key role in providing seafood to the world's population and its role will need to grow in the future, or supplies will be inadequate to sustain current per-capita consumption rates[9].

While the majority of BC's product is exported to the US, the US potential is still untapped. In 1995, BC only supplied approximately 5% of US oyster supplies and 3% of US clam supplies. (Coopers and Lybrand, 1997). Buyers and consumers in the US regard Canadian products with generally high quality perceptions and a willingness to expand imports.

While Asian markets show great potential for Canadian farmed shellfish, they will require intensive and sustained effort to be secured and retained. Order volumes are often extremely large, reinforcing the need for production partnerships in order to create a critical mass. The importance of working with credible buyers and building long term relationships is also key for success in the Asian markets.

7.6 PROCESSING

Dormant or under utilized fish processing plants on the North Coast need to be assessed for potential startup or refitting as a shellfish approved processing facility.

The development of strategic alliances amongst growers and processors is strongly recommended to enable the development of regular harvesting plans, thereby ensure continuity of supply. Well integrated production and marketing plans will enable growers and processors to reduce their costs with respect to processing, marketing and distribution.

A list of all federally registered BC plants is available on the Canadian Food Inspection Agency website: http://active.inspection.gc.ca/active/usresults.asp

7.7 DISTRIBUTION

There are a number of levels between the processor and the final consumer. These include value-added processors, brokers, distributors, wholesalers and retailers all engaged in servicing different target markets. Except on a small scale, neither growers nor processors are supplying either the retail or food service sectors directly, but instead rely on established distributors and wholesalers to manage this function. The shellfish wholesalers specialize in specific market segments – such as upscale restaurants and grocery stores, mainstream grocery and ethnic markets.

Distributors and brokers hold the key for entering into new markets, particularly US markets. Both provide customers with a range of seafood products and can easily control the flow of product into specific markets.

Many new food exporters to the US choose brokers to sell and service their accounts. The advantages of this method are the comparatively low start-up and overhead costs (no sales, no costs), the quick access to an established network of buying contacts, the local presence to service clients, the knowledge of the market and of the product's promotional requirements. Brokers can often be instrumental in helping exporters introduce new products, as many of them have strong relationships with retailers and wholesalers and have regular appointments with their buyers. However, all too often industry relies completely on sales and brokerage firms, rather than actually marketing its own products. While brokers and distributors are extremely useful in establishing connection with a new market, it is critical to stay involved as an active player in the marketing process.

To be successful in the US market, identifying distribution channels and forming relationships based on trust and mutual benefit will be essential. However, additional research will be needed to verify the best opportunities for establishing specific distribution channels and sales networks.

Establishing distribution channels and forming strong relationships is essential for successful market development

7.8 TRANSPORTATION

Modes of transportation will be determined by the type of product, the cost of freight and its effect on price and end delivery targets.

American food distributors and wholesalers prefer to maintain low inventories, so suppliers must be able to provide quick delivery. Canadian third-party logistic companies have recently emerged to provide new exporters with one-stop access to distribution services.

American food distributors and wholesalers prefer to maintain low inventories, so suppliers must be able to provide quick delivery.

Trucking from the Central and North Coast can be used for close markets (Vancouver and Edmonton), and is particularly appropriate for frozen value added products, rather than fresh. While air transport is the preferred transportation method to distant markets, (particularly if dealing in the fresh market) the availability of carriers and routes from Prince Rupert is currently quite limited. Seagoing containers (20 and 40 feet) are other transportation options are available for frozen products.

Since the Central and North Coast will be dependent mainly on exports and transportation costs are a significant factor in the cost of goods produced, it is recommended that First Nations groups explore options of forming strategic alliances or joint ventures with organizations that have market expertise.

7.9 GENERIC MARKETING

BC currently lacks any consistent program or strategy to promote local shellfish within local markets. However, there is currently some focus, through the Canadian Aquaculture Industry Alliance, to develop a national strategy for the marketing of farmed seafood (finfish and shellfish). This is a positive step towards an umbrella approach to Canadian seafood marketing and it is strongly recommended that the North Coast industry stay involved and 'tuned into' this important process. However, a national approach to marketing does not meet all the needs of a growing North Coast industry – the development of a regional brand that tells a specific story and can be promoted within a national strategy is the most effective approach.

Generic marketing campaigns have been effectively used by other agri/aqua-food organizations to increase consumption and/or price of the collective products of all firms within the organization, rather than positioning one firms' product against another. There are a number of key elements that must be in place to ensure a generic campaign is effective:

- ☐ A target market must be established
- ☐ Proper product positioning must be determined
- ☐ Focus must be on the individual product
- ☐ Multi-layering of promotional tools should be employed
- ☐ The product should be differentiated from competitors and
- ☐ There should be a singular theme or idea behind the campaign.

Without generic marketing, grower's unique position at the farm level (i.e. safety, handling, flavor, growing conditions etc.) will not be adequately reflected by market participants further along the marketing chain. Generic programs reflect the values of their product and their growing region directly to the final buyer. In other words, generic advertising permits direct discourse between producers of food and consumers of food products. For this reason, generic advertising has become a popular market expansion device for many North American agricultural and producer organizations.

The objective of generic advertising is to increase the overall profitability of a product on an industry wide basis. In many industries, one firm's gain comes at the expense of another firm's loss. However, generic advertising is the business of making "bigger pies" – so that all firms within an industry can have a bigger piece. Generic advertising thus attempts to make the game more positive for all.

The objective of generic advertising is to increase the overall profitability of a product on an industry wide basis.

Generic advertising:

- adds value to a product by informing and reminding people of its' unique advantages
- increases the consumer's willingness to pay for that value.

This added value can therefore, permit increased profitability through greater sales at the same price and/or the same sales at a higher price. The added value of a product, resulting from the enhancement of its image via generic marketing, may be reflected by:

1) Willingness on the part of consumers to pay a higher price for the product

Example:

- Washington Soft Fruit Commission: The primary goal of this commission's marketing activities is to create an enhanced image of their product – thereby allowing them to obtain the highest possible sale price. Over a 4-year average, the efforts of the commission have resulted in a 20% increase in the price of Washington cherries.

2) An increased demand within existing geographical areas

A study of the demographics and psychographics of a population can reveal **new target markets** as defined by characteristics such as socio-economic factors, age factors and lifestyle.

Example:

- Ontario Pork. In 1998, Ontario Pork formed a strategic promotional partnership with four Niagara wineries. In forming this alliance, Ontario Pork aimed to expand into the world of haute cuisine and fine wines - a market segment relatively unexploited by them prior to this alliance.

3) Increased demand within new geographical locations
Example:

- Washington Soft Fruit Commission. Another major goal of this commission has been to create a positive image for Washington cherries in other countries: as a result of their enhanced image, Washington cherries are now found in 55 countries.

4) Increased demand via creation of new products (i.e. increased versatility)

Example:

- Indiana Soybean Board. To increase the domestic utilization of soybeans, this board is currently promoting innovative ways to use soy in everyday foods (e.g. frozen desserts, protein enhancements and dietary supplements) and in industrial products such as bio-diesel fuels and soy-based solvents.

5) Stabilize profitability in the face of market challenges

Example:

- ❑ Dairy Bureau of Canada (DBC). As Canadian butter sales had been falling for the 1986 to 1991 period at an average annual rate of 3.8%, the objective of the DBC generic marketing program for butter was to slow the decline and maintain profitability. Given the price of butter and the competition from margarine, sales growth for butter was not a realistic goal. In 1992 when the decline was halted and sales were maintained, the generic marketing program was considered to be a success.

Trade Education

There is a strong need to expand any generic marketing program to include an education component for wholesalers, retailers and restaurants about the benefits of shellfish from the North Coast.

Wholesalers need to differentiate the shellfish they are selling by flavor, growing methods, geographic location or other characteristics. Since restaurants and seafood retailers have considerable staff turnover; they need to provide information to their staff on an ongoing basis to ensure consumers have credible information about shellfish. In addition to a good 'story' consumers are extremely interested in safe handling and sustainable farming practices.

Target Marketing

It is critical to focus marketing efforts on target markets with targeted products. All successful marketing programs have clearly identified their target market(s). In other words,, they have clarified what segment of the population they want their promotions to appeal to. Market research will assist in choosing the appropriate segment of the population to target. In the US, individuals 50-64 years of age are 71% more likely to eat seafood than the average American, making the 'baby boomers' a potential target for seafood messages.[10]

7.10 MARKETING RECOMMENDATIONS

Marketing Plan

Before growing any shellfish species, a confirmed marketing plan that matches the production plan must be developed. The plan needs to outline where the product will be processed and which markets are being targeted.

Price

All North Coast shellfish aquaculture operations growing products for distant markets will need to command a premium price in the marketplace to offset the disadvantage of distance.

Partnerships & Alliances

Particularly in the beginning, consideration should be given to forming partnerships with brokers and other trading companies. This will provide better access to foreign markets that these large companies are already associated with.

First Nations groups will need to cooperate and collaborate amongst themselves at every level. The development of strategic alliances amongst growers and processors is strongly recommended to enable the development of regular harvesting plans and thereby ensure continuity of supply. Such alliances would also enable growers and processors to reduce their costs with respect to processing, marketing and distribution.

There is a very strong need to participate with others in the BC shellfish culture industry (i.e. British Columbia Shellfish Growers Association), so North Coast growers have an awareness of programs and initiatives underway. For example, both On -Farm Food Safety Program and National Codes of Practice will have a direct impact on any future marketing initiatives.

The importance and mutual benefits of cooperation between industry members may not be appreciated until issues such as disease, guarantee of product supply or low market prices occur. Cooperation and networking within the industry must be encouraged so that strategic forward planning can be achieved.

Value Added

Central and North Coast business ventures face competitive disadvantages, as compared to South Coast operations, in transportation costs and logistics. The production of secondary, value added products offers the opportunity to remove some of these competitive disadvantages, as the product is not shelf life dependent.

While the majority of farmed shellfish is still sold fresh, consideration must be given to the development of further processed products that can be easily branded as well as transported. Examples are frozen vacuum packed shellfish and frozen shellfish entrees. Due to simple economics, tried and true forms of value adding (i.e. frozen) will be most successful. While a growing trend, innovation always requires investment and risk.

Regional Branding

Regional branding and identification will be key in positioning product in the marketplace. There are definitely market opportunities for the right mix of marketing approach, campaign and product line. Without development of a brand, the product becomes just another oyster (or mussel or scallop), subject to all the price constraints that come with traditional commodity markets.

Research will need to occur to identify what the North Coast brand should be. This is a critical step in the marketing process and is much more than simply choosing a name. It will be necessary to identify what's most important to the market and what the anticipated barriers are to sales. Differentiating where there is the most value to the buyer or consumer and what name and/or positioning statement will serve to move purchasing decisions beyond price.

Product Quality

Ensuring consistency of product quality is a key factor in successful marketing. Given that there may be a number of farms and management styles in operation, high quality standards will need to be considered to ensure brand differentiation and product claims are repeatedly attainable

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[10] Seafood Business, April 2002, Baby boomers reach seafood-loving years.

8.0 Business Development Overview

Table of Contents

8.1 Business Planning for Aquaculture 2
  Financial Feasibility 3
  Cash flow statements 5
8.2 Human Resource Issues 7
  Aquaculture Skill Requirements 7
  Aboriginal Participation in the Aquaculture workforce 9
  The need for basic business skills 10
8.3 Corporate Registration and licensing requirements 12
  Forms of Incorporation 12
  Corporation 13
  Licenses, Permits and Other Requirements 14

8.1 BUSINESS PLANNING FOR AQUACULTURE

Whether it be an individual or a company, any group interested in aquaculture should prepare a business plan to work through mistakes, which may be anticipated and solved on paper. The importance of a written business plan cannot be under emphasized; it exposes thoughts, assumptions and research findings to reason. The business plan takes the perceived goals of a project and explores whether the plan will work and what resources will be needed to initiate the plan and carry it through in the future.

By first modelling the business on paper the prospective shellfish farmer minimizes the risks. Without a business plan, finance sources will be limited. Private and institutional investors require business plans so that they know what they are investing in, how their money will be used and what returns they can expect.

Producing a thorough business plan will:

- Forces the proponent to think about the business, research options, and recognize opportunities and risks. It will also test some of the business assumptions.
- Identify the cash needs for the business.
- Help raise funding from banks and investors.
- Be used to tell investors, employees and others about the business strategy.
- Be used to compare the progress and performance of your business later.

Sufficient time and research to fully prepare a solid business plan must be taken. Often it is necessary to engage professionals to assist with the plan. The larger the project, the larger the relative risks will be and the more attention must be spent on comprehensive business planning.

A good business plan explains the business concept, summarizes the objective of the business, identifies the resources (money and people) that will be needed by the business, describes how those resources will be obtained and tells the reader why the business will succeed.

Guidelines for a good business plan:

Define your objectives- who is going to read the plan and what do you want them to do?

Allocate enough time and resources to thoroughly research your plan. Show drafts of your plan to others to get feedback.

Write your own plan so it reflects needs.

Outline the key points you want to make in each section before you start writing.

Make sure your financial projections are believable.

Do an executive summary last, making it no more than two pages, highlighting what is important in your plan.

Questions to answer in the plan are:
Where are you now?
Where do you want to go?
How are you going to get there?

Three basic concerns are:

- ☐ Who will buy the product?
- ☐ How will the product be produced and with what resources?
- ☐ Will revenues adequately exceed costs?

The common sections of most business plans include:

1. A summary of the key points of the business plan
2. An overview which introduces the reader to the business
3. A description of the products and services
4. An overview of the industry in which the business will compete
5. Marketing strategy which summarizes the product, promotion, pricing and distribution strategies of the business
6. A description of the management and staff
7. An implementation plan
8. A financial plan, which includes pro-forma balance sheets, income statements and cash flow statements.

Historical data such as production, sales, prices and financial indicators can be summarized in a tabular form so that changes over time (e.g. 5 years) can be presented.

Financial Feasibility

Ultimately the business plan will determine what is required for financial feasibility.
Production economics involve various direct costs, which can be divided into systems costs, production costs and processing costs. These factors can be outlined for shellfish aquaculture as follows:

1. Systems costs
    a. Initial facilities investment
        i. Tenures and associated land or land for land based facilities
        ii. Site Development infrastructure, longlines, rafts etc.)
        iii. Buildings, floats grow-out equipment
        iv. Power sources (solar, electrical, fossil fuel)

   b. Maintenance
   c. Land tenure fees
   d. Depreciation
   e. Taxes
   f. Interest on working capital

2. Production costs
   a. Seed (larvae, juveniles, broodstock)
   b. Feed for species if required (such as abalone, urchins etc.)
   c. Labour
   d. Regulatory monitoring costs
   e. Water pumping, heating, oxygenation if required
   f. Fuel (operation and transport)
   g. Miscellaneous supplies
   h. Harvesting
      i. equipment (harvest equipment, shipping containers, vessels)
      ii. labor
      iii. holding and/or transport facilities

3. Processing costs (if applicable to product)
   a. Direct cost to producer
   b. Shipment to processing facilities

Most aquaculture ventures are extremely labour-intensive. The cost of labour usually represents the most limiting factor in terms of production costs. Less labour-intensive shellfish aquaculture ventures are normally limited by high mechanization and capital costs.

Processing can be considered a production cost if existing processing facilities are not available to the producer. Processing costs, as well as the multitude of state and federal regulations governing processing can pose a significant constraint to prospective aquaculturists.

Marketing involves the movement of goods from the producers to the consumers. New aquaculture industries can have significant marketing problems. Ideally, the marketing network for food items involves processors, distributors and outlets. Although a producer can bypass processors and distributors, bypassing these middlemen will greatly increase costs and risks. Because of the additional risks involved, it is desirable to work through an established marketing network that can adapt to new aquaculture products.

When developing a plan it is important that

- ☐ As much is known as possible about the biology and culture expectations of the species being farmed.
- ☐ As much site specific knowledge is known and preferably the results of pilot studies at the site
- ☐ Multiple projections are tested with high and low survival of the shellfish being cultured as well as testing the effects of variable costs on profitability.
- ☐ Contingencies are anticipated and built into the business plan.

Cash flow statements

The cash flow statement is the most important component in the business plan. It is a tool for forecasting profits and expenses and ensuring that money is available when needed. A well-developed cash flow statement shows how much money you need, when you need it and when it is available. Shellfish take years to grow to market size and during this time expenses will be incurred.

The cash flow projections should extend at least 3 years and preferably 5 years or to a point where the operation is consistently at a profit, whichever is longer. Net cash flow is the difference between cash receipts and cash disbursements for the period. Cumulative cash flow is the sum of net cash flows from the starting period to the current period. The cash flow must also incorporate the cost of borrowing money and repayment schedules

Financial plans are best developed using a computer spreadsheet program, which will allow for repeatedly recalculating various factors. These spreadsheet based plans range from the simple to the complex, depending on the amount of detail that is required. An example of s spreadsheet for a commercial shellfish farming operations is shown on the following page.

Table 7.1: Portion of a planning spreadsheet for a commercial shellfish operation showing categories for expenses, production and revenues (only 3 months columns are shown and all values have been removed for confidentiality reasons.

EXPENDITURES			YEAR	02-03	
			JAN	FEB	MAR
LABOUR COSTS	Farm Manager salary	Per year			
	Farm Manager benefits	Percent			
	Salary Labour avg	Per year			
	Salary deduct/benefits	Percent			
	Contract Labour	Per Day			
OPERATING COSTS	Office Overhead	Per year			
	Phone Service	Per year			
	Insurance	Per Year			
	Lease Liability Insurance.	Per year			
	Legal Fees	Per year			
	Book-keeping	Per month			
	Accounting	Per Year			
FEES/LICENCES	Lease Fees	Per year			
	BCSGA Membership Dues	Per year			
	Land taxes	Per year			
DEBT SERVICE	Loan	Per month			
	Bank Charges	Per month			
OPERATING	Maintenance	Per year			
	Misc. Supplies	Per year			
	Marine Freight (Supplies)	Per year			
	Contingency	Per year			
	Boat Fuel/Oil	Per year			
	Accommodation Costs	Per Crew			
	Setting cost	Per million			
	Boat Maintenance	Per year			
	Other				
	Travel	Per Year			
SEED	Single Oyster (x1000)				
	Larval Oyster (million)				
	Manila Clam (x1000)				
CAPITAL EQUIP	XXXXX				
	XXXXX				

PRODUCTION AND HARVEST		Annual Production			
ANNUAL MARKETING	**Total Shellstock**				
	Manila Clams (lbs)				
	Small Oyster (doz)				
	Medium Oyster (doz)				
	Large Oyster (doz)				
	Shucking Oyster (gals)				
		Price/unit			
SALES REVENUE	Small Oyster (doz)				
	Medium Oyster (doz)				
	Large Oyster (doz)				
	Shucking Oyster (gals)				
	Manila Clams (lbs)				
	Monthly Expenditure				

8.2 HUMAN RESOURCE ISSUES

It is widely recognized in the aquaculture industry that a skilled workforce is essential if the Canadian aquaculture industry is to be competitive. It is important to recognize that worker availability and productivity are factors that industry can significantly influence, especially if it acts collectively. This is in contrast to the other market factors, which are primarily determined by political and global forces, which the industry has little control.

Overall, future labour shortages are anticipated for the Canadian aquaculture industry. As the industry grows, the demand for labour will increase. Demographic trends and rural population decline will limit the supply of labour in the future. This trend however, may be beneficial for First Nations who are attempting to develop local employment.

In order to develop a successful shellfish aquaculture development project(s), strong emphasis must be placed on human resources from the outset. These skill sets can be divided into management, who will run the businesses and supervise the workers and technicians who will conduct the husbandry, harvesting and processing duties. It should be noted however, that in order for management staff to succeed in their positions they must also have a very good understanding of the skills and knowledge requirements of the technical staff.

Aquaculture combines the skill sets of both fisheries and agriculture and is more often like the latter. However, production of fisheries products requires a different set of technical and managerial skills than other agricultural activities. Before a would-be shellfish grower can be successful, he or she needs specialized training in water quality, cultural (husbandry) techniques, business management marketing and processing skills. Although an informed aquaculturist can minimize the potential risks associated with raising aquatic organisms, the untrained grower continually faces the possibility of unpredictable disaster.

Aquaculture Skill Requirements

The aquaculture industry comprises 3 broad occupational groups: production workers, managers and technical experts. Some skills that are critical to industry development are outside the industry in the supply and services sector, governments and industry associations. New occupations are being created in the industry due to technological change, development of new species and production of value-added products.

There is a trend towards increasing skill requirements in all occupations. For example, mechanization is transforming production worker jobs from a manual labour orientation to jobs with an orientation towards the use of equipment and fish husbandry.

The range of skills may broaden in the future for a number of reasons including:

- The commercialization of new species and the development of new products.
- Technological change
- The necessity to deal with complex environmental and regulatory issues.
- The increasing size and sophistication of firms in the industry resulting in the need for advanced management and administrative skills.

The recent situational overview of the Canadian Aquaculture industry conducted by PRAXIS Research & Consulting Inc.[i] in 2002 determined the following general points about the training requirements for Canadian Aquaculture workers.

- ☐ Training is critical to labour productivity and innovation in the aquaculture industry. Productivity and innovation are especially important because of the intense global competition in aquaculture and because competitors have some significant advantages over the Canadian industry.
- ☐ The wide variation in skills and skill levels requires diverse training programs.
- ☐ Rapid advances in technology and skill requirements require a dynamic training system.
- ☐ The lack of formal training for existing workers limits skill acquisition in the industry. This is particularly problematic because the industry is characterized by rapid changes in skills and skill levels.
- ☐ Recruitment problems in aquaculture courses could limit the future supply of adequately skilled workers.

Aboriginal Participation in the Aquaculture workforce

Data from the 1996 Statistics Canada Census estimated that 20.7% of the aquaculture workforce in British Columbia was aboriginal. The recent situational overview of the Canadian Aquaculture industry conducted by PRAXIS Research & Consulting Inc. indicated that First Nations involvement in aquaculture will increase significantly, especially in BC, where land claims settlements will provide aquaculture opportunities. Consequently, this review also cautioned that generally First Nations do not have the basic biological backgrounds required to develop aquaculture sites and that increased involvement of First Nations in aquaculture will have unique human resource and training implications.

Aquaculture employment for youth and women

Typically, labour occupations in the aquaculture industry are physically arduous and sometimes entail harsh environmental conditions. Young males have traditionally been most suited to these occupations.

Women account for a high proportion of the processing labour force in the fishing industry and this has carried over into the aquaculture industry. The literature review conducted by PRAXIS indicated that about one-quarter of the aquaculture labour force is female and that female labour is concentrated in the administrative clerk, fish plant worker and labourer occupations. There is a relatively low representation of women in owner/manager and harvest labour occupations.

This may change however; increased mechanization and technological change are making labourers jobs less physical. Mechanical and husbandry skills are becoming more important than physical strength for aquaculture production workers. This trend makes the industry more accessible to women.

Overall, recruitment of young people in the industry is hampered by a number of problems including:

- ❑ The tendency for young people to seek out professional careers and careers in technology. Evidence indicates that young people may feel that aquaculture offers non-professional, temporary job opportunities with no identifiable career path.

- The environmental perceptions of the industry among youth.
- The on-going decline in youth populations in rural areas.

Conversely, the advantages of development of sustainable aquaculture industries that offer long- term employment may assist in keeping youth in rural areas and providing meaningful employment in their traditional communities.

The need for basic business skills

Often in the existing aquaculture industry participants who are attracted to it come from other marine sectors such as the commercial fishery or fisheries sciences and lack the necessary business skills in order to succeed. Whether a business development project involves shellfish aquaculture or any other form of business, basic business skills need to be acquired. In 2000 a survey of new operators in the Newfoundland mussel industry identified the need to develop the following skills within the existing industry:

- Management and Leadership Training
- Management skills in:
  - Cash flow management
  - Inventory management
  - Record keeping
  - Business planning
- Development of strategic alliances that provide strong management support
- Strengthening technical skills and competencies
  - Basic husbandry
  - Quality control

A recent Statistics Canada Survey of over 1000 aboriginal business owners identified the top priorities of successful businesses include the need to improve[ii]:

Management Skills (89%)
Improving Productivity (88%)
Innovation (76%)
Financing (74%)
Employee Training (67%)
Expansion of Markets (67%)

This survey also identified that for aboriginal operated businesses that:

- Aboriginal entrepreneurs with business training run more successful businesses
- Who have developed business plans are more likely to be successful
- Successful aboriginal firms are much more likely to invest in formal training for employees
- On the whole aboriginal businesses are still less likely to formally train employees (14%) than are small Canadian businesses (38%).

8.3 CORPORATE REGISTRATION AND LICENSING REQUIREMENTS

The federal, provincial and municipal governments have certain requirements for the registration of new businesses or businesses under new ownership. The following is a set of general considerations and requirements that affect most businesses.

Forms of Incorporation

Businesses operating in BC may be either incorporated or unincorporated and may be structured according to one of several forms. When considering how a business will be organized legally, you have 4 choices: a sole proprietorship, a partnership, a corporation, or a cooperative. Each has different important implications for liability, taxation and succession.

Sole Proprietorship

Establishing a sole proprietorship is the simplest way to set up a business. In this business structure, one individual performs all the functions required for the successful operation of the business. The proprietor secures the capital, establishes and operates the business, has possession of the business assets and is directly responsible for the debts and other liabilities incurred by the business.

Partnership

A partnership is an agreement in which two or more persons combine their resources with the view of a profit-motivated business. The terms of the partnership and the rights, responsibilities and obligations are typically detailed in a partnership agreement. Partners share in the profits according to the partnership agreement. A partnership does not have to pay income tax. The financial information from the partnership is combined with the personal income of the partners, to determine their overall tax liability.

There are 2 types of partnerships: general and limited.

> **General Partnership:** In a general partnership, responsibility for all aspects of the business is carried jointly by the partners, regardless of the capital contribution of each. Two or more owners share the

management of a business, and each is personally liable for all the debts and obligations of the business regardless of the level of his or her direct investment. This means that each partner is responsible for and must assume the consequences of the actions of the other partner(s).

Limited Partnership: Limited partnership is a special type of partnership that consists of one or more general partners and one or more limited partners. A limited partner contributes only capital to the business. Limited partners cannot act on behalf of the company nor be held responsible for the liabilities incurred by the company beyond the extent of their investment. General partners are fully liable for the debts and obligations of the business, but may be entitled to a greater share of the profits.

Corporation

A corporation is a legal entity separate and distinct from its owners, the shareholders of the company. Typically, the shareholders of a corporation are protected from most of the liabilities of the business. Ownership interests in a corporation are usually easily changed. Shares may be transferred without affecting the corporation's existence or continued operation.

The following characteristics distinguish a corporation from a partnership or proprietorship:

- Limited liability – no member can be held personally liable for the debts, obligations or acts of the corporation beyond the amount of share capital the member has subscribed; and

- Perpetual succession – the existence of a corporation, which is a separate and legal entity, does not depend on the continued membership of any of its shareholders.

A corporation is a separate legal entity that exists under the authority granted by either provincial or federal law.

Licenses, Permits and Other Requirements

1. Registering A Business Name

Business operating as a sole proprietorship, a partnership (i.e., general or limited) or a limited company fall under provincial or territorial jurisdiction and must first register with the province by filing a name approval with the Corporate Registry. Once the name is approved, it is reserved for 56 days until it is registered with the Corporate Registry of the Ministry of Finance and Corporate Relations.

If a sole proprietor chooses to operate a business under a name other than his or her own; he or she must register with the province by filing a Name Approval Form with the Corporate Registry. However, if the proprietor establishes a business in his or her own name, without adding any other words (e.g., "and sons" or "and associates"), it is not necessary to register the business.

A registration package can be obtained from any Government Agent's office. The business should be registered prior to obtaining a business license. Allow at least 7 days for name search and registration.

Corporate Registry
2nd Floor, 940 Blanshard St
Victoria, BC

Mailing address:
PO Box 9431 Stn Prov Govt
Victoria, BC V8W 9V3

Tel: (250) 387-7848
Fax: (250)356-0206
From Vancouver call:
(604)775-1041
Web Site:
http://www.fin.gov.bc.ca/registries/corppg/

2. Business Number

A Business Number (BN) is assigned when one or more of Canada Customs Revenue Agency's 4 major business accounts are opened. The 4 accounts are:

- corporate income tax
- import/export
- payroll deductions
- Goods and Services Tax (GST).

The BN is a numbering system that identifies the various accounts maintained by a business. Business Number Registration Kits can be obtained from Business Windows, located in many Canada Customs and Revenue Agency offices in BC.

Canada Customs and
Revenue Agency
Business Window
1166 West Pender St
Vancouver, BC V6E 3H8

Tel: 1-800-959-5525
Fax: (604) 691-4446
Website:
http://www.ccra-adrc.gc.ca

See also:
Business Registration On-line:
http://www.businessregistration-inscriptionentreprise.gc.ca/

3. Goods and Services Tax (GST)

An individual, a business or an organization operating in Canada with worldwide annual revenues from taxable supplies of goods and services over $30,000 must register for GST. If annual GST-taxable sales and revenues are under $30,000, there is no requirement to register, but voluntarily registration is possible for the purposes of commercial activity. A BN will be assigned after registration for GST.

General Information for GST Registrants:
http://www.ccra-adrc.gc.ca/E/pub/gp/rc4022eq/rc4022eq-03.html

4. Workers' Compensation Board (WCB)

Most business operations in BC are required to have compensation coverage about 80% of all employers. Employers who are uncertain about their need to register for compensation coverage should contact the WCB for information.

Overall responsibility for complying with the Workers Compensation Act and WCB Regulations and for paying assessments rests with the employers, as the controllers of the workplace.

Head Office:
Workers' Compensation Board
6951 Westminster Hwy
Richmond, BC V7C 1C6

Tel: (604) 273-2266
Fax: (604) 244-6490/244-6392
Toll Free: 1 800 661-2112
Web Site:
http://www.worksafebc.com

5. Obtaining a Business License

Municipalities normally require businesses to be licensed before operating within municipal boundaries. In some instances, persons may be required to obtain licenses in municipalities in which they do not maintain premises, but do carry on business. For example, persons involved in mobile services to consumers should contact each community in which they are doing business.

Business licenses are available from the municipal office. Fees and types or licenses are determined by municipal bylaws and may vary from one municipality to another.

If your business is located in an incorporated municipality (city, town, village or district), obtain a business license from the municipal business license office. Refer to the blue pages of the telephone book for contact information on an individual municipality.

Figure 8.1. Summary of necessary licenses, permits, and registration for shellfish aquaculture businesses.

Small Business Licenses and Permits

- Registered Business Name
- Canada Customs Revenue Agency Business Number
- Goods and Services Tax (GST) Number
- Workers' Compensation Board (WCB) Compensation Coverage
- Municipal Business License (within municipality)

Aquaculture Licenses and Permits

- Land and Water British Columbia Inc. (LWBC) Approved Shellish Management Plan
- Canadian Environmental Assessment Agency Marine Environmental Assessment (if required)
- LWBC Tenure Lease/License (BC Lands File #)
- Upland Owner Consent (if required)
- Ministry of Agriculture, Fisheries and Food (BCMAFF) Aquaculture License
- MAFF Bon-Afide Aquaculture Certificate (-Aquaculture PST emeption)
- Public Liability Insurance for Tenure Operation
- DFO/MAFF Seed Transplant Permit

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[i] PRAXIS Research & Consulting Inc. 2002. Situational Analysis of the Aquaculture Industry of Canada. Prepared for the Canadian Aquaculture Industry Alliance. 99p.

[ii] Caldwell, D. and P. Hunt. 1998. Aboriginal Business: Characteristics and Strategies for Growth. Industry Canada/Aboriginal Business Canada, Occasional Paper #20.

9.0 Shellfish Aquaculture Governance and Licensing

Table of Contents

9.1 Governance of Aquaculture 2

Federal Responsibilities 3

Provincial Responsibilities 5

Local Governance 6

First Nations 6

9.2 Guide to Shellfish Aquaculture Application & Licensing Process 7

Introduction 7

First Nations and Shellfish Aquaculture Memorandum of Understanding 7

First Nations Memorandum of Understanding 8

Crown Land Application Process 9

9.3 The Canadian Environmental Assessment Act and Shellfish Aquaculture 21

What is Environmental Assessment? 21

Types of Environmental Assessments Under CEAA 22

Understanding CEAA Assessments for Shellfish Aquaculture 22

Information Requirements, Policy and Guideline Documents 24

9.4 BCMAFF Environmental Code of Practice 26

9.1 GOVERNANCE OF AQUACULTURE

Aquaculture development is dependent on a harmonization of federal and provincial policies and regulations. The province has title to most public lands in BC and the legislative power to manage and sell those lands. Federal jurisdiction resides over conservation and protection of fisheries resources, use of federal public property, seacoast and inland fisheries, navigation and shipping and First Nation's issues. Often, there is an overlap between federal and provincial legislative powers.

In BC, Fisheries and Oceans Canada (DFO) is responsible for all tidal invertebrate species with the exception of pacific oysters, which are managed by the province. Title to intertidal foreshore, which is the area between high and low water, exposed at low tide and the land under water, is vested in the province. The right to lease this land rests with the province.

Aquaculture in Canada is subject to a complex of institutions, guidelines, and injunctions that forms the regulatory environment. The resulting hurdles to aquaculture businesses span transnational organizations, conventions, and accords; federal government agencies and legislation; provincial agencies and legislation; and a number of miscellaneous organizations and associations. In short, there is an absence of an overall rational model for the assessment of net social economic benefits in aquaculture. The current regulatory environment is dysfunctional[1].

However, there is intense frustration within the Canadian Aquaculture industry as to how the industry is managed and regulated (sidebar). It is generally felt by the Aquaculture industry that the complex matrix of overlapping federal and provincial government responsibilities leads to excessive regulatory requirements and uncertainty. It is important that prospective aquaculturists realize the implications of federal and provincial regulations and how they impact developing aquaculture operations.

While the Canadian Aquaculture industry has great growth potential, it currently operates without an appropriate policy, regulatory and legislative framework. Most of the measures in place today were not developed with aquaculture in mind and thus are often applied to the sector in an inconsistent manner. Many of the regulations under the Fisheries Act are not well adapted or directly relevant to aquaculture—a situation that results in the aquaculture industry being managed as a subset of the traditional fisheries. This is analogous to equating traditional livestock and crop agriculture to the hunting and gathering of animals and plants[2].

General Government Administration:

- *Land* – public or "Crown" lands (including submerged lands) administered by the provincial government
- *Land-use* - provincial responsibility, but local government (Regional Districts) through Official Community Plans and zoning take authority
- *Marine waters* – fisheries, fish conservation and protection, marine shipping and navigation responsibility of the federal government
- *Fish habitat protection* – both federal and provincial
- *Farm practices* – both federal and provincial
- *Fish inspection and processing* – both federal and provincial
- *Fish export* – federal

Specific areas of government responsibility and influence:

- Land-use – Ministry of Sustainable Resource Management (MSRM), Regional Districts, First Nations, DFO
- Land tenure – Land and Water BC (LWBC), BCMAFF, First Nations
- Licensing and monitoring shellfish farming – BCMAFF, DFO
- Species cultured – BCMAFF, DFO
- Seed imports and shellstock transfers – BCMAFF, DFO
- Shellfish harvesting and product safety – BCMAFF, DFO, CFIA, EC
- Processing, buying and selling shellfish – BCMAFF, CFIA, DFO, DFAIT
- Training programs – HRDC, Ministry of Education

Federal Responsibilities

There are many departments and agencies with responsibilities relating to the aquaculture sector at the federal level (sidebar). Broadly speaking, when seafood is at sea, it falls under federal jurisdiction.

Federal Agencies with Roles in Aquaculture:

Agriculture and Agri-Food Canada
Canada Customs and Revenue Agency
Canadian Food Inspection Agency
Animal Health Production Division
Fish and Seafood Production Division
Canadian International Development Agency
Department of Finance
Department of Foreign Affairs and International Trade
Environment Canada
Canadian Environmental Assessment Agency
Farm Credit Corporation
Fisheries and Oceans Canada (DFO)
Office of Sustainable Aquaculture (DFO)
Office of the Commissioner of Aquaculture Development (DFO)
Health Canada
Heritage Canada
Human Resources Development Canada
Indian and Northern Affairs Canada
Industry Canada
National Research Council Canada – IRAP Programs
Western Economic Diversification Canada
Natural Resources Canada
Natural Sciences and Engineering Research Council
Statistics Canada

A Description of the roles of Federal Agencies involved with the regulation and support to the industry may be found at:

http://ocad-bcda.gc.ca/eregulationandsupport.html

DFO is responsible for the regulation and management of wild finfish and shellfish fisheries (with the exception of wild oyster harvesting), marine navigation and major project reviews under the federal *Fisheries Act*, *Navigable Waters Protection Act* (NWPA) and *Canadian Environmental Assessment Act* (CEAA).

Critically important to shellfish aquaculture is the Canadian Shellfish Sanitation Program, (CSSP) which defines the practices and protocols required to assure the safety of harvested shellfish (farmed or wild harvested). This program is jointly administered by: the Canadian Food Inspection Agency (CFIA), DFO and Environment Canada (EC). A further description of this program is provided in Section 6.0.

The following Federal acts and regulations govern shellfish aquaculture in British Columbia:

- Appropriation Acts
- Canada Shipping Act
    - Boating Restriction Regulations
- Canadian Environmental Assessment Act
- Canadian Environmental Protection Act
- Canada Wildlife Act
    - Wildlife Area Regulations
- Coastal Fisheries Protection Act
    - Coastal Fisheries Protection Regulations
- Employment Equity Act
    - Employment Equity Regulations
- Excise Tax Act
    - Agriculture and Fishing Property (GST/HST)Regulations
- Feeds Act
    - Feeds Regulations
- Financial Administration Act
- Fisheries Act
    - Aboriginal Communal Fishing Licences Regulations
    - Fishery (General)Regulations
    - Fish Health Protection Regulations
    - Fish Toxicant Regulations
    - Management of Contaminated Fisheries Regulations
    - Marine Mammal Regulations
    - Pacific Fishery Regulations
    - Canadian Shellfish Sanitation Program
- Fisheries Development Act
- Fish Inspection Act
    - Fish Inspection Regulations
- Food and Drugs Act
    - Food and Drug Regulations
- Freshwater Fish Marketing Act
- Health of Animals Act
- Health of Animals Regulations
- Migratory Birds Convention Act

- Navigable Waters Protection Act
- Pest Control Products Act
    - Pest Control Products Regulations
- Oceans Act

Provincial Responsibilities

The primary agencies within BC with responsibility for regulating the shellfish aquaculture industry are the:

BC Ministry of Agriculture, Food and Fisheries (BCMAFF) is the lead provincial agency responsible for aquaculture. Under the authority of the *Fisheries Act,* BCMAFF is responsible for the development and regulation of the aquaculture industry, evaluating the suitability of production proposals and providing licensing for aquaculture operations. BCMAFF is committed to providing the business climate for a competitive and profitable industry providing safe, high quality food for consumers and export markets.

http://www.agf.gov.bc.ca/fisheries/Shellfish/shellfish_main.htm

BC Ministry of Water, Land and Air Protection (MWLAP) is responsible for regulating waste management, environmental monitoring and enforcement. The mandate of the ministry is to:

- Protect human health and safety by ensuring clean and safe water, land and air;
- maintain and restore the natural diversity of ecosystems, fish and wildlife and their habitat; and
- provide park and wildlife recreation services and opportunities to British Columbians and visitors.

http://www.gov.bc.ca/wlap/

BC Ministry of Sustainable Resource Management MSRM is responsible for land use planning and management in the province. The ministry was established in June 2001 to provide a single access point to planning, data and information about Crown land and resources by integrating and streamlining functions previously performed by numerous ministries and agencies.

http://www.gov.bc.ca/srm/

Land and Water British Columbia Inc. (LWBC) is a crown corporation responsible for the leasing and/or sale of Crown land. Established in 1998, this agency of the provincial government handles up to 80% per cent of the

http://lwbc.bc.ca/for_business/shellfish/

province's land mass. LWBC is responsible for administering the Crown tenure process for shellfish aquaculture. A, a full description of this process is included in Section 8.2.

Provincial legislation and regulations pertaining to aquaculture in British Columbia

- Aquaculture Regulation
- Aquaculture Waste Control Regulations
- Corporation Capital Tax Act
- Environmental Assessment Act
- Farm Practices Protection Act
- Fisheries Act
- Freedom of Information and Protection of Privacy Act
- Industrial Development Incentive Act
- Lands Act
- Municipal Act
- Small Business Venture Capital Act
- Social Service Tax Act
- Waste Management Act
- Wildlife Act
- Fish Inspection Act
- Water Act

Local Governance

Regional Districts and local governments have authority to influence and regulate present and proposed local land uses and development, including activities on leased Crown lands. They regulate through Rural Land Use Zoning Bylaws, zoning bylaws, permits and other instruments.

First Nations

First Nations have a land use role in their territories and are a referral agency in the siting of new aquaculture tenures.

9.2 GUIDE TO SHELLFISH AQUACULTURE APPLICATION & LICENSING PROCESS

Introduction

Land and Water British Columbia Inc. is responsible for land use allocation decisions and provides tenure rights to Crown land, foreshore and aquatic Crown land on behalf of the province under authority of the *Land Act*. In addition, LWBC processes water license applications under the authority of the *Water Act* and in accordance with existing water use policy as required to support aquaculture tenures. To enhance client service, federal and provincial agencies have agreed that LWBC will be the "single window" for all new aquaculture applications and renewals of tenure.

The Land Management Division handles existing Crown land tenures and applications for new tenures. Tenuring is the process by which property rights are granted to Crown land. A tenure is a legal contract between the province and the holder of the tenure. A tenure can be a lease, license, permit or right- of- way. Through this agency, applicants can apply for Crown land shellfish aquaculture tenures and the aquaculture license required under the *Fisheries Act*.

The policies and procedures developed by LWBC may be revised from time to time to ensure that LWBC procedures continue to meet the needs of key stakeholders.

First Nations and Shellfish Aquaculture Memorandum of Understanding

In order for new shellfish tenures to be issued on the North Coast, LWBC requires that community consultations be conducted within First Nation communities. These consultations are aimed at determining:

- Areas of highest interest (often the most valued shellfish sites); and
- Number and size of sites First Nation communities can realistically manage as farms.

Subsequent to this, the areas of highest interest are reviewed with LWBC and BCMAFF to:

- Ensure feasible amount of land being proposed;
- Consider consistency with agreements between LWBC and other First Nations; and
- Check the status of the sites.

First Nations Memorandum of Understanding

In order to provide shellfish farming opportunities for First Nations, LWBC is negotiating and signing Memorandums of Understanding (MOUs) with First Nations whereby

LWBC agrees to:

- Protect potential aquaculture sites, identified by First Nations, for 10ten years for First Nation shellfish aquaculture purposes;
- Waive the due diligence requirements for five years once the tenures on these sites has been granted; and
- Support any later shellfish arrangements between BC and the First Nation, flowing from BCTC (?) treaty discussions or other negotiations.

The First Nation agrees to:

- apply for tenures within 10ten years of signing the MOU;
- to participate in the community consultation process for their area when it occurs; and
- participate in any landscape–level consultation in the area and respond to LWBC referrals of specific tenure applications.

LWBC and BCMAFF can assist with the preparation of tenure applications, specifically in the creation of development plans. However, LWBC does not currently have funding for business plan development. INAC (?) business support may make funding available. Alternatively, a Treaty-Related Measure for business plan funding is possible. LWBC and BCMAFF can also help facilitate funding proposals by the First Nation.

Crown Land Application Process

Where an Economic Measure MOU is in place with First Nations and where community criteria for tenure selection has been established for shellfish aquaculture, new applications will be accepted for suitable sites where they do not conflict with sites identified in the MOU.

In the absence of a formal Economic Measure MOU or MOU sites selection agreement with First Nations, LWBC will accept shellfish tenure applications. Applicants are asked to identify a site that is suitable for their needs within that area and complete an application package.

Each application for Crown land tenure goes through 4 stages.

Stage 1: Preparing a Crown Land Application

Application procedures vary according to the proposed use of the Crown land and the type of tenure. Application packages for proposed use can be obtained from the LWBC. website (www.lwbc.bc.ca) or contact:

Duncan Williams, Aquaculture Manager
Phone: (250) 741-5667
Address: Suite 501-345 Wallace Street, Nanaimo, BC, V9R 5B6

Application Eligibility

Before preparing an application, the applicant must:

- ☐ meet the general requirements and any specific eligibility requirements for the proposed tenure ;
    - a Canadian citizen or permanent resident, 19 years of age or over; or
    - a corporation registered in BC or incorporated under Canadian law; or a registered partnership in BC or Canada; or
    - First Nations can apply through band corporations or Indian Band and Tribal Councils. Band or Tribal Councils require a Band Council Resolution a) authorizing the council to enter into the tenure arrangement, and b) giving the signatories of the tenure document the ability to sign on behalf of the Band; or
    - for foreshore leases, be the Canadian or non-Canadian

owner of adjacent uplands.

- will not have more than 520 hectares of Crown land under application at one time.

It is strongly recommend that all applicants meet with LWBC shellfish staff prior to making application in order to conduct a preliminary status check of the site and to identify potential areas of concern that may arise over the application.

In descending order of complexity, the greatest amount of information and assessment is required for:

- a lease;
- a license of occupation; and
- an investigatory permit.

A lease is usually issued when:

- long-term tenure is required;
- substantial improvements are proposed; and/or
- definite boundaries are required in order to avoid conflicts.

The maximum term for a lease is 30 years.

A license of occupation is usually issued when:

- minimal improvements are proposed; or
- short-term tenure is required.

The normal term for a license of occupation is 20 years.

An investigatory permit is issued:

- to allow for the investigation of project feasibility or the placement of monitoring equipment.

The maximum term for an investigatory permit is 2 years.

Acquire and complete the shellfish application package

Applicants for new tenures and tenure expansions must provide:

- a non-refundable application fee of $475, plus GST, as per the *Land Act*;

Site plan tips:

- ***When describing a parcel of land, it must be in the form of a metes and bounds description that is tied to nearest surveyed parcel of land . The description and boundaries must encompass and completely enclose the land, starting and finishing at the point of commencement.***
- ***Grid paper makes it easier to draw your plan or sketch map of the application area. Be sure to give measurements and show an approximate scale on your plan.***
- ***For applications that encompass large areas of Crown land (i.e. some uses under the Commercial Recreation Program, or large linear utilities under Telecommunications) a smaller scale overview map may be sufficient at the initial stages of the application***

- an additional $75, plus GST, application and documentation fee is required for new licenses under the provincial *Fisheries Act*;
- an Application for Commercial Aquaculture License;

any additional information requested in the Application Guide for Aquaculture Projects;

- a complete Marine Environmental Assessment of your application;
- standard LWBC. forms, including the Application for Crown land and staking notice and the Economic Impacts Questionnaire;
- a Shellfish Management Plan describing the type of development, the proposed species and the projected anticipated production levels; and
- 5 copies of the above documents are required initially and reviewed by a provincial/federal agency review team. The purpose is to ensure all the appropriate data and information is contained in the application package to ensure (need a new word) timely decisions by the appropriate agencies. The team will review the application for completeness and identify any information gaps. When applications are deemed to be complete, a total of 12 copies of the application will be requested. These copies will be sent to the appropriate referral agencies.

Shellfish Management Plan

The Shellfish Management Plan is a critical component of many tenure applications. A written management plan details what activities will take place on the Crown land and how, when, and where they will occur. A guide is included in the application package to assist with completing the management plan. A successful Shellfish Management Plan must contain:

- a description of the type of development proposed;
- timing of the capital development / time required to set up the operation;
- type of shellfish to be produced;
- projected production levels;
- any planned buildings and their location;
- a marine chart showing the proposed location in an appropriate scale, identifying land features and including a North arrow;

- a detailed site plan of the area (1:5000 or 1:1000), which identifies all improvements and proposed work on the site, location of access roads, watercourses, district lots and major landmarks as reference points, boundaries and an accurate metes and bounds description;
- for an expansion application, a single plan must be submitted that includes both the expansion area and the existing tenure. It must include existing and proposed improvements, as well as, seeding and production estimates that encompass both areas.

A management plan should include, *when relevant*, the following:

- the company's or applicant's business history;
- a Certificate of Incorporation;
- a prospectus;
- a staking notice form or, when Crown land is partially unsurveyed, the land must be staked using LWBC Form 1 as well as the usual application form;
- a copy of the State of Title of the requested property;
- a copy of survey plans and charges described in the Title indicated above;
- photos showing the nature of the Crown land;
- the operation, activities, level of use, and anticipated number of clients;
- impacts of the proposed use on the land, resources and other users or interest groups;
- measures to eliminate or minimize any conflicts with other users,
- protection of environmental integrity; and
- means to ensure public access.

In order to obtain management plan information, the applicant may have to finance expert studies such as economic feasibility or environmental impact studies (See Section 8.3).

The final approved management plan will become part of the legal tenure document. It will be the basis by which LWBC will monitor and enforce specific performance requirements during the tenure.

LWBC regional staff is available to answer questions with the preparation of the application materials.

The completed application package is submitted to the appropriate LWBC regional office or business unit for consideration.

Joint Applications

When an application is made by 2 or more people, each applicant's full name must be listed and each name is followed by either "joint tenancy" or by "tenancy in common" to indicate the type of tenancy.

Joint tenancy: If a joint tenant dies, his or her interest in the land passes automatically to the remaining joint tenant(s).

- Tenancy-in-common: If a tenant-in-common dies, his or her interest in the land can be willed to heirs and does not automatically pass to the remaining joint tenant(s).

Stage 2: Initial Review of the Crown Land Application

Application Acceptance

Upon receipt in a LWBC office, every application is registered in a database, which allows staff to easily track the progress of the application. All applicants are given a file number and a LWBC contact name.

New applications will be immediately placed into a pre-application status for up to 37 calendar days, while the proposal is reviewed for acceptance.

LWBC staff will review the application to determine whether the application:

☐ is complete;

☐ is from an applicant who meets eligibility requirements;

☐ is for a land use administered by LWBC;

☐ is consistent with existing land use plans for the area;

☐ does not seriously conflict with existing tenures or uses; and

- ☐ provides reasonable justification for the use, site and amount of land being proposed.

For all shellfish applications received and accepted by LWBC, an aquaculture Project Review Team (PRT) will have 30 days to undertake an initial screening to:

- ensure proponents have provided adequate technical information for government agencies to effectively review the application package; and
- review and compare applications against approved siting criteria and evaluate whether all the required siting buffer information has been provided.

The PRT will include representatives of all federal, provincial and municipal agencies with jurisdictional responsibility or a recognized interest in the project.

Other steps in the initial review include:

- ☐ checking existing land use maps and LWBC status maps (see below) to ensure there is no obvious conflict between the proposed use and existing uses;
- ☐ checking for potential impacts to areas of environmental, social or cultural significance; and
- ☐ reviewing the size, location and configuration of an application area to ensure it suits the nature and type of proposed activities.

LWBC Status Maps

These status maps show the location of all private land, other land tenures, ecological reserves and areas covered by existing land use plans. Status maps are found at LWBC offices.

Checking these maps against an application can reveal potential problems early in the application process.

Stage 3: Evaluating the Crown Land Application

Assessment of Crown land applications is based on these principles:

Best Use: allocating land to compatible and suitable uses, as determined by interagency referrals, social and economic needs;

Limited Supply: recognizing that that the supply of suitable and available land is limited; and

Equity and Fairness: ensuring equal and fair treatment of all applicants through consistent policies and fair market value pricing.

Key steps in evaluation of an application are:

- ☐ referrals to other agencies/ stakeholders;
- ☐ assessment of Aboriginal interest;
- ☐ DFO review process by Regional Aquaculture Coordinator and the Sectors within DFO
- ☐ advertising of the application;
- ☐ review of land status;
- ☐ potential for sustainable land use; and
- ☐ field inspections

Referrals

Application packages are sent to agencies at all levels of government, local community organizations and stakeholder groups, First Nations communities and any parties who may have an interest in the specific application.

LWBC developed an agreement with 8 provincial agencies to clarify and simplify the responsibilities and procedures with respect to referrals of Crown land applications.

This agreement ensures that LWBC will make Crown land allocation decisions which support the government's objective of a thriving economy, while protecting the environment and respecting Aboriginal rights and the mandates of other provincial agencies.

The referral process *may* include:

- ☐ federal agencies, such as(CCG) or DFO;
- ☐ provincial ministries, including MWLAP, Forests, Small Business, Tourism and Culture, Transportation and Highways,

Aboriginal Affairs and Energy and Mines;

- First Nations;
- Stakeholder or special interest groups;
- local and regional governments;
- current holders of Crown land tenures covering the same area; and
- local interest groups and organizations.

Aboriginal Interest Assessment

To meet the province's responsibilities to First Nations when dealing with Crown lands, LWBC has developed Aboriginal Interest Assessment Procedures.

These procedures guide consultation between LWBC and First Nations communities in the allocation of Crown land. LWBC also works closely with the provincial Ministry of Aboriginal Affairs.

DFO Review Process by Regional Aquaculture Coordinator

A site application is received from the province by the Regional Aquaculture Coordinator, which is then forwarded to several sectors within DFO for review and assessment in accordance with their legislated mandates:

- CCG - (*Navigable Waters Protection Act* sections 5 and 6(4));
- Habitat Management – (habitat protection provisions of the *Fisheries Act* and environmental considerations under CEAA);
- Fisheries Management (potential concerns related to the commercial, recreational, and Aboriginal fisheries); and
- Science (*Fisheries Act* – Introductions and Transfers, Fish Health Protection Regulations; advice to other sectors).

Advertising

Applications must be advertised in a local newspaper, the BC Gazette, and the Canada Gazette using a format provided by LWBC.

Advertisements must clearly describe:

- the tenure location;
- types of activity proposed; and
- the rights that may be granted.

Advertising gives the public an opportunity to learn about and comment on an application.

Staking

Staking is required for aquaculture applications. A person intending to apply for Crown tenure is required to post a notice indicating his or her intention to do so at the intended location. The notice must contain the applicant's name and address, the site being applied for by local name, the area of application, a metes and bounds description (including latitude and longitude) and the purpose of the application.

Land Status

LWBC undertakes a detailed status review of the land for which the application is made. Status maps and land use plans are thoroughly reviewed to ensure the subject land is available for allocation under the *Land Act*.

Staff also look for:

- any legal encumbrances;
- potential environmental issues;
- community concerns; and/or
- user/client conflicts.

Sustainable Land Use

The commercial viability of an application to provide viable and sustainable economic benefits is assessed based on information from:

- the applicant;
- local, regional, provincial and federal government agencies;

- ☐ local communities; and
- ☐ stakeholder groups.

Field Inspections

The need to conduct a site inspection will vary between each file. The general policy of LWBC regarding field inspections for new aquaculture applications is as follows:

- Site inspections will be carried out on all applications, except where an alternate process (e.g., an Environmental Assessment (EA)) will address the majority of concerns.

LWBC and BCMAFF will co-ordinate and share information on field inspections and may invite other relevant federal and provincial agencies to participate in inspections. Site date collected by other federal and provincial agencies may be used by LWBC.

Stage 4: Decision on the Crown Land Application

The target turn-around time for tenure decisions is 140 days from when the application is accepted by LWBC, not including the time taken for review of the Crown land application by the Aquaculture Project Review Team.

Decisions on tenure applications are based on:

- ☐ input from the referral process;
- ☐ field inspections;
- ☐ public consultation with agencies, relevant stakeholder groups and the general public;
- ☐ review of responses to advertising; and
- ☐ tenure area status information.

The proponent will be notified in writing of the outcome of adjudication by either:

- a disallowance letter from the assigned Land Officer when an application will not be granted based on the above information; or
- an offer of tenure and a tenure agreement if the proposed

development is acceptable.

If the proposed development is not yet acceptable but would be if changes were made, the applicant will be given the opportunity to change the proposal.

Revising a Proposal

Modifying the original proposal often answers concerns raised during the assessment so the tenure can be approved.

Changes could include:

- ☐ requiring fencing or staff training to protect sensitive environmental areas;
- ☐ changes to the timing or location of activities to minimize potential resource use conflicts; or
- ☐ restrictions on some uses in response to local or First Nation concerns.

These conditions can be incorporated into the legal tenure documents.

Offer of Tenure

When a tenure decision is made or a successful applicant selected from a competitive process, LWBC makes an offer of tenure.

The offer may include preconditions, which must be completed before LWBC will sign the tenure document.

Preconditions will include, but not limited to:

- ☐ Buying liability insurance;
- ☐ annual rental
- ☐ Management plan fee
- ☐ Posting performance bonds; and

The tenure document will state that the client must:

- ☐ obtain required permits or licenses from other agencies, prior to occupying the site.

A copy of the tenure document and an offer letter are sent to the successful applicant.

To obtain the tenure, the applicant must:

- ☐ meet the preconditions of the offer;
- ☐ sign the documents and return them to LWBC; and
- ☐ pay the documentation fees which come due when the final tenure documents are issued.

LWBC then approves the tenure and returns an original set of documents to the applicant. These documents are a legal contract between LWBC and the tenure holder.

This contract states:

- ☐ what the individual or corporation is entitled to do with the Crown land;
- ☐ how these activities are to be carried out; and
- ☐ the rent and/or royalties due, which are usually paid on the anniversary date of the tenure.

Failure to honour contract conditions or to make payments is a breach of the contract and will result in enforcement actions by LWBC

9.3 THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT AND SHELLFISH AQUACULTURE

What is Environmental Assessment?

Environmental assessment is an important planning and decision-making tool. It is an organized information gathering process used to identify and understand the effects of proposed projects on the biophysical environment (air, water, land, plants and animals) as well as on the social and economic environments of the people to be affected.

In pursuing the goal of sustainable development, the government uses planning tools such as environmental assessment. Consideration of environmental effects early in the planning stages of a project promotes better planning. Environmental effects are identified, assessed and where possible, plans are made to minimize these effects before irreversible decisions are made. Environmental assessment can save time and money.

The process also promotes public discussion of a proposal. This leads to a consideration of those effects, which cannot always be identified or measured by scientific or technological means. It also gives the public an opportunity to have input into the decision-making process.

What is the Canadian Environmental Assessment Act?

The *Canadian Environmental Assessment Act* is the legal basis for the federal environmental assessment process. The Act sets out, for the first time in Canadian legislation, the responsibilities and procedures for carrying out the environmental assessments of projects, which involve the federal government.
The Act is founded on a number of guiding principles:

- A healthy environment and healthy economy can be achieved by making sure that the impacts on the environment are known before federal decisions are made.
- The environmental assessment process should be applied as early as possible in the planning stages of a project.
- The environmental assessment process promotes international cooperation by learning from, sharing information with, and offering Canadian expertise to other countries.

Finally, through public information booklets, fact sheets, bulletins and an annual report to Parliament tabled by the Minister, the agency also promotes greater public awareness of the important role environmental assessment plays in Canada.

When must the federal government conduct an environmental assessment?

The federal environmental assessment process is applied whenever a federal authority exercises one or more of the following duties, powers or functions in relation to a project (Act, Section 5):

- Proposes a project;
- sells, leases, or otherwise transfers control or administration of land to enable a project to be carried out;
- contributes money or any other form of financial assistance to a project;

Types of Environmental Assessments Under CEAA

There are four types of environmental assessments under CEAA:

- ☐ Screening (including class screening);
- ☐ Comprehensive study;
- ☐ Mediation;
- ☐ Review panel.

The summary of the EA conducted, including the conclusion on whether the project is likely to cause significant adverse environmental effects, will be summarized in the EA (screening) report.

Understanding CEAA Assessments for Shellfish Aquaculture

Shellfish aquaculture projects have the potential to affect fish and fish habitat. DFO, as part of the provincial tenure referral process, is responsible for the protection and management of fish habitat under the authority of the *Fisheries Act* and may request plans, specifications and environmental assessments specific to such projects where more detailed information is required.

Recent policy changes by DFO have resulted in new requirements and clarification of the DFO review process for aquaculture development applications. This includes consideration under theNavigable Waters Protection Program, Fisheries Management and the Habitat Management Program.

Of special importance to shellfish aquaculturists in British Columbia is the Navigable Waters Protection Program (NWP) administered by Canadian Coast Guard (CCG). The legislation that supports this program is the *Navigable Waters Protection Act* (NWPA). When an application is referred to DFO/CCG a determination is made by the NWP authourity whether a proposed project will substantially interfere with navigation and thus be considered "*work*"under the terms of the NWPA.

A favourable environmental assessment must be conducted in order for DFO to issue a permit necessary for a shellfish farm to go forward.

If an activity occurs in navigable water and is a deemed to be a "*work*" NWP refers the project to the DFO Habitat section for consideration under CEAA. This includes most finfish and shellfish deepwater operations. DFO becomes a "*responsible authority*" (RA) and is required to ensure that an environmental assessment of an aquaculture project is conducted under the *Canadian Environmental Assessment Act* (CEAA) when DFO proposes to issue one or more of the following[3]:

- a paragraph 5(1)(a) or subsection 6(4) approval under the *Navigable Waters Protection Act* (NWPA);
- a subsection 35(2) *Fisheries Act* authorization.

These are known as "*law list*" triggers and a favourable environmental assessment must be conducted in order for DFO to issue a permit necessary for a shellfish farm to go forward.

Section 2 of CEAA defines "environmental effect" as including:

> "*any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, and any change to the project that may be caused by the environment, whether any such change occurs within or outside Canada.*"

"Environment" is defined by CEAA as:

> *"the components of the Earth, and includes land, water and air, including all layers of the atmosphere, all organic and inorganic matter and living organisms, and the interacting natural systems that include the above-noted components."*

The majority of marine aquaculture projects (e.g., mussel long lines, oyster rafts) requiring an environmental assessment will undergo a "*screening*". The screening is a systematic approach to documenting the environmental effects of a proposed project and determining the need to minimize or mitigate these effects; to modify the project plan; or to recommend further assessment through mediation or a panel review.

Section 16 of CEAA indicates that every screening of a project must include a consideration of the environmental effects of the project, including a consideration of "*any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out*".
During an environmental assessment, potential environmental effects relative to the project under review and mitigation measures to minimize/reduce these effects are identified in order to assess whether the project is likely to cause significant adverse environmental effects.

Information Requirements, Policy and Guideline Documents

Fisheries and Oceans Canada has developed a *Guide to Information Requirements for Environmental Assessment of Marine Shellfish Aquaculture Projects.* This guide sets out the minimum information to be provided to DFO through the CEAA process. Other documents that should be considered in the preparation of the CEAA screening include:

- *CEAA Practitioners Guide to Cumulative Environmental Assessment*
- *DFO Aquaculture Site Application Review Process and Interim Guidelines*
- *DFO Interim Guide to Fisheries Management Role in the Evaluation of Aquaculture Site Applications*
- *DFO Interim Guide to Information Requirements*

  for Environmental Assessment of Marine Shellfish Aquaculture Projects

- ○ *DFO Interim Guide to Marine Foreshore Environmental Assessment Procedure*
- ○ *DFO Interim Guide to Application and Site Marking Requirements for Aquaculture Projects in Canada*

DFO has prepared standardized, transect-based assessment procedures intended to provide the basic information required to determine the potential effects of proposed developments on fish habitat. Specifically the focus is on the potential benthic impacts on fish habitat. Currently, the marine Foreshore Assessment procedure requires the extensive use of dive video transects to complete the benthic assessment:

> *"Transect lengths will normally extend from the HHWM to a point extending approximately 25 m beyond the tenure boundary and spaced approximately 25 m apart. The number of transects required will depend on the nature of the proposed activity, the anticipated affects of the development and the local site conditions (tides and currents, habitat variability, geography, fetch, geology, etc.)."*

DFO will make recommendations for necessary information requirements on a project-to-project basis. Typically when conducting an EA for shellfish aquaculture work will include:

- ☐ Habitat assessments, digital photography records, GPS transects, etc.
- ☐ Assessment of local *Valuable Environmental Components (VEC's)* and *Valuable Social Components (VSC's)* that may be affected by the project.
- ☐ Video transects of benthos
- ☐ Additional data gathering as necessary.

9.4 BCMAFF ENVIRONMENTAL CODE OF PRACTICE

The development of an enforceable Code of Practice (COP) for the BC shellfish industry by BCMAFF is an important initiative. It is intended to serve as a guideline to shellfish aquaculture companies to ensure their operations are conducted in a manner that works in concert with the marine environment. The COP will provide guidance for addressing and minimizing negative environmental impacts related to normal farm practices on shellfish aquaculture tenures. The COP will promote the responsible development and management of a viable and responsible BC shellfish aquaculture sector.

For more information on the Code of Practice please visit the BC Ministry of Agriculture, Fisheries and Food website at the address below:

http://www.agf.gov.bc.ca/fisheries/shellfish/cop.htm

The provincial COP will be enforceable as a condition of shellfish aquaculture license. The COP reflects the normal operating practices to be adhered to by all BC shellfish farmers, as the industry currently exists. Compliance with these normal farm practices will set a baseline standard for shellfish aquaculture operations in British Columbia. The successful integration of a COP into shellfish business operations will allow the industry to build credibility with the public, environmental groups and regulators and enhance its position as a responsible steward of the marine resource.

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[1] Neil, R and B. Rogers 2002. Canadian Aquaculture: Drowning in regulation. How to Farm the Seas (Paper #11) B. Crowley and G. Johnson (editors). Atlantic Institute for Market Studies. Halifax available at: http://www.aims.ca/Publications/Aquaculture/aquaculture.pdf

[2] Office of the Commissioner for Aquaculture Development (OCAD). 2001 Legislative and Regulatory Review of Aquaculture in Canada. Communications Branch Fisheries and Oceans Canada. Ottawa DFO/6144

[3] The above assumes that a determination has been made that the aquaculture proposal in question is a "project" under CEAA.

10.0 Shellfish Aquaculture Project Development

Table of Contents

10.1 Project Planning and Organization 2
  Level of Interest 2
  Realistic Expectations 2
  Consultation 3
  Integration with Community Values 3
  Environmental Sustainability 3
  Compatibility with Other Industries 4
  Organization and Networking 4
10.2 Business Models and Structures 6
  First Nations Development Corporation 6
  Individually Held Corporations 6
  License Royalty Arrangements 7
  Joint Ventures 7
  Other Corporate Structures 7
10.2 Case Study: Development of the Newfoundland Mussel Industry 8
  Situational Overview and Rationale for Comparison 8
  Rapid Growth 8
  Strategic Planning in the Newfoundland Industry 10
  Move to Secondary Processing and Economies of Scale 12
  Using the Newfoundland Experience to Translate Production to Process Requirements 13
10.3 Securing Sufficient Business Investment 15
  International Competition for Industry Development – Some Examples: 15
  Attracting In-Bound Investment 17
  Target Markets for Shellfish Aquaculture Investment 18
10.4 Role of Joint Ventures in Development 20

10.1 PROJECT PLANNING AND ORGANIZATION

Shellfish aquaculture can play an important role in providing First Nations with the potential to develop a livelihood that is sustainable, in tune with the environment and consistent with human and natural resources.

Shellfish aquaculture can play an important role in providing First Nations with the potential to develop a livelihood that is sustainable, in tune with the environment and consistent with human and natural resources. It also offers an excellent opportunity to increase the economic independence of First Nations communities. These factors are linked to the importance of communities being involved in and having a strong influence on the design and implementation of any proposed shellfish aquaculture business. Shellfish aquaculture is an ideal way for First Nations people to become involved in an industry at its inception and thereby participate in its development.

The key elements of the consultation and planning process are as follows:

Level of Interest

The driving force behind any development needs to come from within communities, not government or other groups.

For First Nations shellfish aquaculture projects to succeed, the driving force behind any development needs to come from within communities, not government or other groups, since the latter option may be seen as setting up projects that would inevitably fail. The interest for shellfish aquaculture development must come from the communities themselves. Once initiated, interest has to be maintained from within the communities, mainly by one or more advocates or 'champions' who continue to drive development projects.

Realistic Expectations

It is essential for stakeholders and other community members to be fully aware of what is involved in shellfish aquaculture, to have a realistic expectation of the rewards and returns as well as the long term effort needed to achieved success.

At a community level, it is essential for stakeholders and other community members to be fully aware of what is involved in shellfish aquaculture, to have a realistic expectation of the rewards and returns, as well as the long term commitment in time and effort needed to achieved successful outcomes.

It will be important to ensure that the planning and development process outlined in this strategy does not create unreasonable or high expectations among First Nations communities. The purpose of this study is to provide First Nations communities in the Central and North Coast with recommendations and a strategy to accelerate the development of shellfish aquaculture, and not to generate unrealistic or high expectations.

Consultation

Effective consultation with First Nations and their meaningful participation in all stages of the planning and development processes are essential prerequisites for successful First Nations shellfish aquaculture development.

Development strategies need to make provision for adequate time for consultation with communities, be sensitive to the cultural practices and beliefs of the relevant communities and to identify and accommodate specific community needs. During the consultation process, matters such as social and business values and preferred forms of ownership and management, need to be discussed.

During the consultation process, matters such as social and business values, and preferred forms of ownership and management need to be discussed.

Integration with Community Values

During internal consultation, First Nations communities need to contribute their traditional knowledge of the local environment and ecological processes before any development takes place. The affinity many First Nations hold with aquatic resources and their traditional skills constitute a valuable resource for shellfish aquaculture development.

During the development of this regional strategy, there has been a focused attempt to be sufficiently flexible to accommodate the diversity of First Nations communities and situations within the region. Different communities will prefer and seek different approaches to shellfish aquaculture development varying from extensive practices that reflect cultural beliefs and values to semi-intensive and intensive systems involving significant capital expenditure and high levels of management and technology. A little long The use of intensive production systems may not be appropriate for all communities, particularly those located in extremely remote areas with little infrastructure. More extensive or semi-intensive practices may be better suited to these communities. As a specific example, cockle clam production requires lower levels of investment and can be managed at lower levels of intensity.

The affinity many First Nations have with aquatic resources and their traditional skills constitute a valuable resource for shellfish aquaculture development.

Environmental Sustainability

Communities interested in the industry need to carefully consider why they want to enter into it, as well as be aware of any potential risks (i.e. financial) that may be involved. The clear identification of the underlying issues and their capacity to be fulfilled are fundamental to success. As part of the planning process, it will be necessary to ensure that potential partners, whether government or private companies and organizations are aware of environmental and cultural concerns and ensure that appropriate methods are employed to eliminate or mitigate any adverse effects of the proposed project. It is critical that culturally sensitive areas are not disturbed, while due emphasis is placed on environmental management and sustainability.

To ensure success, the following social, cultural and environmental issues must be considered before embarking on any shellfish aquaculture venture:

- ☐ Projects should not adversely impact environments on which communities are socially or culturally dependent.
- ☐ The overall regional strategy needs to be sufficiently flexible to accommodate the individualities of and differences between communities.
- ☐ Adequate consultation with communities is essential.
- ☐ Proposed projects should be compatible with the cultural practices of communities.
- ☐ Conflict arising from differences within and between communities needs to be overcome.

Compatibility with Other Industries

Development in shellfish aquaculture and compatible industries such as recreation and tourism are possibly interdependent and may in fact be mutually beneficial. The eco-tourism industry is experiencing rapid growth and may provide an excellent opportunity for First Nations projects to capitalize on additional revenue generated from tourism. It is recommended that the option of integrating First Nations shellfish aquaculture development planning within the larger context of planning for the overall economic development of communities and regions be explored.

Organization and Networking

Regional Coordination

To achieve the objectives of this regional strategy, the implementation of its recommendations and in order to expedite the involvement of First Nations communities in business ventures, it would be important to establish a small steering committee in both the North and Central Coasts. First Nations shellfish aquaculture would be unlikely to succeed if it was undertaken in isolation from the remainder of the industry, which already possess skills and experience that would be of value to communities. Clearly, the best development climate is one of cooperation and networking.

In the North Coast, the **North Coast Water Quality & Biotoxin Program** *would serve as the appropriate committee.*

In the North Coast, the *North Coast Water Quality & Biotoxin Program* would serve as the appropriate committee, as it consists of local First Nations and non-First Nations communities, shellfish farmers, scientists, economic development groups and local, provincial and federal government representatives.

The principal tasks of the steering committee will be to:

- ☐ review the recommendations provided in this study and establish a schedule for their implementation;
- ☐ implement the recommendations by allocating tasks and initiating further studies according to the schedule;
- ☐ liaise with government agencies to promote and implement the strategy;
- ☐ network with other BC shellfish organizations (BC Shellfish Growers Association, Centre for Shellfish Research etc.). To optimize the use of limited resources, maximize efficiency and take advantage of any possible synergies that may exist, it is critical that a high level of co-operation and communication be established between the steering committee and the established industry players on the South Coast.
- ☐ provide oversight and co-ordination of activities, including initiation and maintenance of water quality regulatory programs.

Aquaculture Coordinator

Consideration should also be given to the hiring of a Coordinator for the Steering Committee.

Consideration should also be given to the hiring of a Coordinator for the Steering Committee, who would assist the Committee and the communities in:

- ☐ site selection and application process;
- ☐ assistance with assessing business plans and administration of funding for projects;
- ☐ contact with government agencies, other shellfish organizations and training facilities;

- ☐ identifying and documenting opportunities, including the identification of impediments and the means that can be used to overcome them;
- ☐ assuming a mentoring role to various First Nations groups involved or seeking to become involved in aquaculture; and
- ☐ acting as a conduit, reference point and source of information for all First Nations aquaculture projects.

10.2 BUSINESS MODELS AND STRUCTURES

Prior to engaging in any sort of shellfish aquaculture business development, First Nations groups should establish basic business goals and legal advice in determining what sort of formal business structure will best suit their needs. A brief review of common approaches is provided below:

Prior to engaging in any sort of shellfish aquaculture business development, First Nations groups should establish basic business goals and legal advice in determining what sort of formal business structure will best suit their needs.

First Nations Development Corporation

Some aboriginal communities incorporate what is comparable to a crown corporation, i.e. a private corporation where all shares are owned by the First Nation, band council, or community government. Some aboriginal groups find this governmental development corporation model helpful for a number of reasons. The community as a whole controls the enterprise. The directors are often the chief /eldersand councilors. The shareholders hold the shares in trust for the community as a whole. They spend the income for social purposes or re-invest it in further economic development.

Individually Held Corporations

Other corporations are formed to provide individuals with opportunities to engage in economic activity either as project managers or subcontractors. There is often therefore, two tiers of corporations. One tier which the community at large owns one way or the other, to manage the large projects in the community. The second tier is owned by individuals who benefit from subcontracts and ancillary work on major projects, or are simply small businesses which the council encourages to serve the community or to reach out to the world to market their unique goods and services.

License Royalty Arrangements

License royalty arrangements are a quasi-commercial activity involving arrangements which are often described as joint ventures where for example, aboriginal governments or their economic development corporations receive a license royalty for resource which the government grants to the aboriginal community by virtue of its adjacency to the resource. Types of license royalty arrangements where there is payment of a mineral royalty, oil and gas royalty, stumpage, water royalty, environmental continuity royalty, biodiversity copyright payment and other similar types of arrangements. Sometimes the parties involved style them as joint ventures, sometimes they regard them simply as the aboriginal government's exercise of a taxing power. This may be applicable in some First Nations communities if shellfish tenure areas are held by First Nation and then developed by other commercial interests.

Joint Ventures

Aboriginal joint venture projects include the association of First Nations interests with one or more groups combining property and expertise to carry out a single business enterprise and having a joint proprietary interest, a joint right to control and a sharing of profits and losses. These may take many structures and are further discussed in Section 10.4

Other Corporate Structures

There are many other business structures which may be utilized for the development of shellfish aquaculture enterprises including corporations with share capital, corporations without share capital, co-operatives, partnerships limited or otherwise, sole proprietorships, economic development corporations and aboriginal councils.

10.2 CASE STUDY: DEVELOPMENT OF THE NEWFOUNDLAND MUSSEL INDUSTRY

Situational Overview and Rationale for Comparison

In the early 1990s the province of Newfoundland began to actively develop a shellfish culture industry. In comparison to the more established PEI and Nova Scotia mussel culture industries, the Newfoundland industry was remote, starting relatively from scratch and subject to severe weather conditions and transport logistics.

The growth of the Newfoundland mussel industry and the comparison with the more established PEI shellfish culture industry is analogous to the current situation between Central and Northern British Columbia and the established South coast shellfish culture industry.

In many ways the growth of the Newfoundland mussel industry and the comparison with the more established PEI shellfish culture industry is analogous to the current situation between Central and Northern British Columbia and the established South coast shellfish culture industry.

The Newfoundland mussel culture industry suffered (and according to some is still suffering) severe growth pains. The Newfoundland industry has subsequently identified many of the causes and solutions to the industry issues it was/is facing and the lessons learned should be used to guide development in Northern British Columbia to prevent the mistakes from repeating themselves.

Rapid Growth

Commercial mussel culture in Newfoundland was at very low levels in the early 1990s. In 1995, the industry produced 404 tonnes of mussels with a value of approximately $0.3 million.

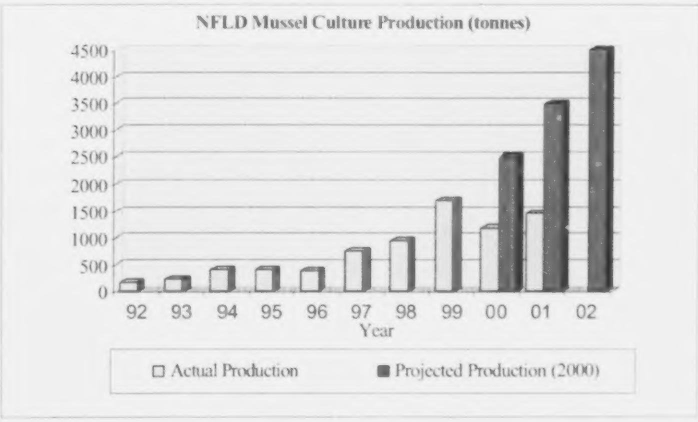
The aquaculture industry in Newfoundland was viewed as a way to assist with recovery after the Atlantic cod crisis. The industry received significant government support with large numbers of tenures granted and government financial assistance to new farmers provided. Between 1995 and 1996 there was a 46% growth in issued aquaculture site licenses with the largest number going to the mussel sector. Many of these sites were established without serious consideration to biophysical capability.

This level of government support continues. The aquaculture component of the Economic Renewal Agreement concluded in 2001 will provide more than $20 million in joint federal/provincial funding over 5 years. This funding was directed to research and development, education, extension services, and coastal planning.

With increased tenures and government and private investment, mussel production began to increase significantly in 1997 and by 1999 the value of the industry had grown 10 fold with an export value of $3.8 million. In 1999, the industry produced 1700 tonnes on 2652 hectares of area with average farms producing at less than 20% of capacity. The industry was at that time, providing between 200 and 250 jobs.

At that time, the future for the industry appeared rosy. In early 2000, production was projected to reach 3,500 tonnes in 2001 and to further increase to 4,500 tonnes in 2002 (having an estimated value of $8,424,000)[1]. In 2000, an estimated 1,100 tonnes were left on farmer's sites due to "soft" market conditions. Actual production in 2001 was less than half the projected value. In effect, the mussel industry stumbled significantly as a result of concentrating on production without putting all the necessary components of a successful industry together.

Figure 10.1 Actual and projected production (tonnes) for Newfoundland Mussel culture production in 2000.



Industry problems encountered:

Even as production was increasing in 1999, critical problems affecting industry growth were beginning to emerge. The Newfoundland industry developed was based almost exclusively on fresh sales to markets in Canada and the United States. A Mussel Marketing group was founded with provincial assistance, which engaged a broker dealing with the Boston fresh "commodity" market. Although the market for fresh mussels had shown strong growth in the past decade, the increased production in Newfoundland came at a time when the PEI producers were also increasing production and competing internally by lowering their prices.

Even as production was increasing in 1999, critical problems affecting industry growth were beginning to emerge.

Newfoundland processors faced competitive disadvantages in transport and logistics compared to PEI producers. Newfoundland producers were hampered by the seasons, having difficulties moving fresh product off the island due to ferry costs, schedules and winter delays. Additionally, seasonal and site product quality problems were encountered. Husbandry and marketing inexperience led to issues with inconsistent product quality in the market place. Many new entrants to the industry did not have the business skills, or understanding of production cycles to become successful growers.

The combined effects of rapid growth without targeted marketing, inefficient production, inconsistent quality and inability to compete in the market place efficiently led to lack of financial viability, which had severe consequences and threatened the success of the industry.

Strategic Planning in the Newfoundland Industry

In 2000, a strategic plan was developed for the Newfoundland and Labrador aquaculture industry that examined emerging issues facing the industry[2]. Issues facing the industry identified in industry strategy report included:

1. **Poor implementation of best husbandry practices** leading to inefficient production (lack of training).
2. **Inefficient Production Costs**: Cost reductions required to improve farm viability.

3. **Insufficient Output:** In 2000, most sites were producing less than projected output often generating as little as 5 – 15% of projected revenues. Primary reasons included:
    - Lack of technical know-how viz husbandry and biology;
    - High expectations of production levels;
    - Lack of operating money;
    - Insufficient attention to management (site and business); and
    - High variability between sites.
4. **High shipping costs** to processing plants often coupled with poor plant yields. This required farmers to insure that product was of high quality before shipping and that collaborative measures were taken between farmers to reduce expenses.
5. **Lack of Farm Clustering and Critical Mass:** Farmers who were not situated in areas with high concentration of mussel growers were at a significant disadvantage. Processing facilities did not operate in areas with small-scale production.
6. **Poor site utilization** compared to PEI producers, which were using similar tenure area and producing 10 times the volume.

Priorities identified for the Newfoundland industry in the 2000 strategy document included:

- Increasing private sector investment, strategic alliances and other forms of collaboration with the industry.
- Reducing costs to improve farm viability.
- Automation and improved husbandry practices to increase yields.
- Investments in equipment necessary to improve operating efficiencies.
- Increasing utilization of approved sites.

- Increasing economies of scale for growers and processors through growth and increased collaboration.
- Regionalization of processing capacity was necessary to reduce the costs relating to transporting mussels for processing over long distances.
- Capacity additions have to be based on sound business plans backed by adequate product supply and established marketing relationships.

The critical strategic issue that was identified as the top priority for grow-out was[3]:

> ***The need to build the profitability of existing full time dedicated growers, who are committed to building a professional mussel aquaculture industry, through increased production volumes. There should be no attempt to increase the number of farmers.***

Move to Secondary Processing and Economies of Scale

Although many production issues still remain in Newfoundland, the solution to the economic viability of the industry is largely linked to move to secondary value added processing and grower/processor relationships.

Although many production issues still remain in Newfoundland, the solution to the economic viability of the industry is largely linked to move to secondary value added processing and grower/processor relationships.

Value added products and markets expanded in 2001 with approximately 60% of total fresh production being further processed into secondary products[4]. These products include frozen "boil or microwave in bag" or items such as mussel salad.

The switch to value added products removes Newfoundland products from the fresh market and the associated shelf-life, transportation and commodity pricing issues. It also generates more local employment by creating shore-side processing jobs.

A relevant example of this approach is Triton Ocean Products in the village of Triton, Newfoundland.

> *Triton serves as the local service centre for over 2,800 people in the surrounding area. Until the 1992 cod moratorium, Triton's economy was centered on the groundfish fishery. Aquaculture is expanding in the area with 30 approved mussel farm sites in the area. Triton Ocean Products, a locally owned company, recently opened a secondary mussel processing plant with plans to employ up to 70 people*[5].

from the
Cool Clean Waters
of Newfoundland
ocean
MUSSEL
Salad
MOULES
En Salade
high in
Nutrition & Protein
low in F·A·T
PRODUCT OF NEWFOUNDLAND
Ingredients: Mussels, water, vinegar red peppers, green peppers, onions
PRODUIT DU NEWFOUNDLAND
Ingredients: Moules, eau, vinaigre, poivrons, oignons
TRITON OCEAN PRODUCTS
Reg # 0050
Triton, Newfoundland, Canada A1A 1A1
99187 00002

The Newfoundland strategy also warned that the secondary processing sector must guard against over capitalization.

With secondary and regional processing comes the requirement for critical mass. The Newfoundland strategy article identified that critical mass for a region must exceed 1000 tonnes and for viability of individual isolated farms, it was suggested that annual production of greater than 250 tonnes was needed, given their higher cost structure. In order for Newfoundland to become a "player" in North American production, it was estimated that the industry would have to achieve a level of approximately 5000 tonnes.

The Newfoundland strategy also warned that the secondary processing sector must guard against over capitalization. Over capitalization leads to competition for resources, reduced efficiencies and reduced profits. Care must be taken to ensure that participants are able to reach an economic level of production.

Using the Newfoundland Experience to Translate Production to Process Requirements

The Newfoundland experience pointed out that secondary processing may be a significant factor in the success of a remote shellfish aquaculture industry and that in order to justify capital investment in secondary processing equipment, a critical mass of farm production must be attained.

Using market or processing requirements, a development strategy can determine the amount of farm production and farming area that must be developed. Using the experiences of the Newfoundland mussel industry, an example of this would be the use of a continuous mussel cooker used to process for "microwave in bag" products. A continuous mussel cooker is worth between $200,000 – 300,000 and may be matched with grading, conveying and packaging equipment worth that amount. A continuous cooker and its associated production line will process approximately 1 tonne per hour. Assuming daily production of 8 tonnes, only 125 processing days annually will be required to process 1000 tonnes of product.

This can then be translated back to necessary harvest rates and farm production volumes. During those 125 processing days, farm harvests must be able to exceed 8 tonnes per day and potentially double or triple that amount to maintain production during weather shutdowns, etc.

To further extend this example, using potential mussel production rates of 2.5 – 5 kg of mussels (*Mytilus edulis*) produced per metre of sock at a seeding rate of 10,000 metres of sock per hectare and a two year rotation, this would require between 40 – 80 hectares of farm area in full production to support the process[6]. Lower rates of production per metre of sock are typically achieved with *Mytilus galloprovincialis*, for the above example this would potentially require a doubling of the farm area.

10.3 SECURING SUFFICIENT BUSINESS INVESTMENT

New business investment and development is a key strategy to achieving the goal of building sustainable communities and local economies.

New business investment and development is a key strategy to achieving the goal of building sustainable communities and local economies. In order to develop an established commercial shellfish aquaculture "industry", external investment in the millions of dollars, not thousands will be required; additionally this must be high risk, patient capital. While some institutional and government support may be realized, project development cannot always be developed solely from within. To be successful, development projects will often require outside technology, expertise and investment capital to grow.

First Nations must recognize that there are not large numbers of companies who are actively looking to acquire tenures and develop shellfish aquaculture in their territories. The Canadian regulatory environment for aquaculture, business uncertainty relating to land claims, high business costs relative to remoteness and lack of established infrastructure all work to discourage investment.

Non-Native groups who are most likely to develop shellfish aquaculture in Central and North Coast regions are most likely to be other local residents who have much in common with local First Nations from the perspective of establishing a viable industry in the region.

It is important to acknowledge that just as aquaculture is a global industry, investment also looks globally. If First Nations are trying to attract outside investment to initiate larger scale projects they must ask themselves; what attributes do they possess that would make private investment develop joint ventures or provide capital financing in their territories versus investing in Southern British Columbia or for that matter other countries where the industry is better established?

International Competition for Industry Development – Some Examples:

Some recent examples of areas in which industries are being created with significant investment include:

Ireland:

> *Aquaculture in Ireland is becoming increasingly important, both in terms of increased production and employment, and today the*

aquaculture sector in Ireland accounts for over 25% of the total value of Irish seafood. Production has increased from 25,560 tonnes (£29,900) in 1990 to 40,000 tonnes (£61,000) in 1998…
"The Aquaculture component of the National Development Plan 2000- 2006 was launched Friday 23rd 2001 by Mr. Hugh Byrne T.D., Minister of State at the Department of the Marine and Natural Resources…
… The Government through BIM will support the development of the aquaculture sector by providing financial assistance and technical, environmental and quality programmes in support of the aquaculture industry
… EU and Exchequer grant assistance amounting to some 630.7 million IR£4 is being made available. Eligible applicants include sole traders, partnerships, companies and cooperatives engaged in aquaculture on a commercial basis that comply with the appropriate planning and licensing requirements. Assistance generally is provided at a rate of up to 40% (5% Exchequer and 35% EU) of eligible costs for the development of the principal commercial species e.g., salmon, trout, mussels and oysters and up to 45% (10% Exchequer and 35% EU) for the commercial development of novel species and new technology development[7]".

Vietnam:

Investment of US$ 65 million to develop Aquaculture near Ho Chi Minh City.

Chile:

Puerto Montt, Chile: 53 coastal fishermen's unions from Chile's Region X are currently taking part in a programme to farm oysters and scallops. As reported by Puerto Montt newspaper El Llanquihue, about 1,300 coastal fishermen from the province are now involved in the project, which was started in 1997. It was set up by Foundation Chinquihue, a private foundation whose president is Region X's intenda. Thanks to this foundation, oysters and scallops are already being grown in captivity and sold in Chile's main markets. The project has cost more than US$ 7 million (US$ 5 million were donated by the Japanese government). It aims to provide the zone's coastal fishing sector - which has suffered severe problems as a result of the depletion of fishery resources with a new business alternative[8].

Vincony Chilena Ltd., a Japanese owned subsidiary of the Japanese Institute of Cellular Materials Co., recently invested approximately CAN$ 5 million into a state of the art on land abalone hatchery in the Calderas Region of Chile. This facility will produce abalone geared to Japanese market standards which will be air-freighted live or sea freighted frozen. The abalone in the facility will be fed with locally produced farmed kelp[9].)

At a fisheries ministers meeting taking place in conjunction with

> *Expopesca in Chile, the Norwegian government fisheries representative, Elsbeth Trosntad, said that Norwegian investment in Chile had reached USD$ 600 million, with virtually all of it going to aquaculture and related industries, like feed plants*[10].
>
> *During the last 20 year Chile has followed a development strategy based on exports. As a result, today Chile is probably one of the only Latin American economies that exports the largest proportion of its Gross Domestic Product. Fundación Chile, a private non-profit corporation specialized in transferring to Chile technologies already proved in other countries, has been part of that process. A main characteristic of Fundacion Chile's work has been the importance given to marketing, to the identification of market opportunities before starting its technical work. One of the most interesting experiences of Fundacion Chile is the creation of new enterprises as a mechanism of innovation and transfer of technology. This mechanism is an alternative to the traditional way in which technical organizations promote innovation: rendering services to a client. Since 1982 Fundacion Chile has created approximately 30 new companies in four of the most dynamic sector of Chilean economy: Agribusiness, Marine resources, Forestry and Informatics. Once the demonstration process is completed, these companies are sold to private investors.*[11]

Attracting In-Bound Investment

Attracting new businesses and business recruitment, also known as the attraction of inbound investment, is about bringing new monies into communities from companies or individuals to establish new businesses or relocate or expand existing businesses.

To be successful at attracting inbound investment, First Nations communities need to take an extremely focused, well-researched and targeted approach. Understanding the shellfish aquaculture industry and the opportunities First Nation communities can offer to joint ventures and the marketing of this opportunity is critical.

To be successful at attracting inbound investment, First Nations communities need to take an extremely focused, well-researched and targeted approach

An aggressive and targeted marketing program is required to create the investment. In order to raise capital to grow shellfish products, First Nations and their partners must first be prepared to market a different product: the investment opportunity itself. This will involve developing a marketing plan and then implementing that plan.

Investment Marketing Plan Development will require identifying the target investment group(s) and understanding the issues that are important to the potential investors or partners. The plan must also identify the product that the community is prepared to offer and the capabilities and opportunities they can provide to an outside investor or joint venture partner. This may involve determining how a First Nation compares as a competitive site for new investment as compared to its competition? What sites does it have to offer? What about available skilled labour, training and infrastructure?

Once the First Nation understands the issues that are important to the potential partner it can analyze what it has to offer and how that opportunity compares to the competition. they are ready to market the opportunity and can develop a marketing plan.

Once the marketing plan is complete, the specific actions and activities that it delineates will be implemented. Details with respect to this implementation will flow directly from the marketing plan. Implementation of the marketing plan involves proactive communications and building relationships with individual or groups who can influence inbound investment.

Target Markets for Shellfish Aquaculture Investment

For shellfish aquaculture, joint venture projects that ensure connection between the grower, processor and buyer will be necessary to develop innovation needed in the marketplace. Groups who may purchase, process, import or retail farmed shellfish products are the most likely candidates for joint venture partners. Attracting these groups requires a targeted investment attraction strategy, preferably conducted with government assistance, both to assist in the market strategy and to assist in securing project investment.

For shellfish aquaculture, joint venture projects that ensure connection between the grower, processor and buyer will be necessary to develop innovation needed in the marketplace.

Success stories must be developed, First Nations must be able to show or point to successful projects that will demonstrate ability. Target groups should not just be focused on traditional players, but should look to develop partnerships internationally and with groups who are perhaps not involved in BC production.

Examples of the types of partnerships that might be pursued include but are certainly not limited to:

- ☐ Canadian or US processors interested in developing value added frozen in bag mussel products.
- ☐ Japanese scallop farming cooperatives to develop scallop-farming operations using Japanese technology transfer.
- ☐ Japanese Urchin importing companies (or Canadian exporters) to develop urchin roe enhancement projects.
- ☐ Japanese Roe on Kelp importing companies (or Canadian exporters) to develop higher value Roe on Kelp products using farmed kelps.
- ☐ Japanese market to develop oyster products grown for and to Japanese market specifications.
- ☐ Chinese or other Asian market buyers to develop oyster products grown for and to market specifications for frozen half shell (TVO).
- ☐ Targeted investment attraction with Norwegian salmon farming companies that are also involved with mussel culture development in Norway.
- ☐ Promoting shellfish poly-culture with fin-fish farming operations.
- ☐ Approaching Asian companies to develop kelp-farming operations (i.e., Nori) using Asian technology transfer.

10.4 ROLE OF JOINT VENTURES IN DEVELOPMENT

Joint ventures and aboriginal economic development: You can't even be like you once were yourself, let alone like somebody else.
http://www.wob.nf.ca/News/1999/Nov 99/joint_ventures1.htm

Joint ventures with groups from outside First Nations territories may be a critical way to bring investment, management, and technology transfer to economically viable aquaculture development projects. It is imperative that First Nations considering this route understand how joint ventures work.

The following brief summary has been taken from an excellent article by Newfoundland Lawyer John Joy, which the reader is urged to consult for more information[12].

A joint venture is an association of two or more natural or legal persons combining property and expertise to carry out a single business enterprise, which has a joint proprietary interest, a joint right to control, and a sharing of profits and losses. In any joint venture while the partners will no doubt watch one another, examine contracts and bank statements and perhaps even sue one another, they should respect and recognize their respective contributions.

Principal distinguishing characteristics of a joint venture include:

Pursuit of a Common Commercial Purpose

> *Joint ventures involve a common objective among all the participants. While there may be a common commercial purpose, the participants must be aware of the different talents, assets, interests, and objectives which each of them brings to the joint venture.*

Balanced Bargaining Power

> *The heart of any joint venture arrangement is the system of checks and balances necessary to give each party sufficient influence to contribute to the entire enterprise.*

Sharing Risks and Rewards

> *In most cases this aspect involves the sharing of profits and losses, but it can also have other features such as employment, transfer of technology, buy-out options, management training, and project management. In general, a joint venture tends to involve parties of roughly equal bargaining power and concerns the pursuit of a common goal. From a legal point of view, the most important aspects are to create a system of*
>
> *Checks and balances to control the rights and liabilities of each participant with respect to each other, and to*

control the common business relationship with third parties.

The functional characteristics of joint ventures are many and various. Five characteristics that are important to aboriginal joint ventures are:

a) **Trust**
If negotiating parties doubt that they can trust one another then there is no point in entering into a business relationship. The business is generally only profitable when the legal relationship between parties operates smoothly.

b) **Action**
Joint ventures not only provide to their participants rights and benefits, they also impose duties, obligations and undertakings.

c) **Term of Relationship**
Joint ventures can be for one short-term project only. They can be for a medium period of time with or without a buy-out option or they can be for an indefinite term like many employment contracts.

d) **Aboriginal Contributions**
The aboriginal partner can bring many things to the joint venture:

- ✓ Access to Special Markets
- ✓ Access to Special Services
- ✓ Aboriginal Knowledge
- ✓ Aboriginal Government Services
- ✓ Aboriginal Lands
- ✓ Aboriginal Labour
- ✓ Aboriginal Capital
- ✓ Aboriginal Entrepreneurship

e) **Partner Contributions**
The partner will normally bring to the joint venture:

- ✓ Capital
- ✓ Labour
- ✓ Entrepreneurship
- ✓ experience in business
- ✓ management
- ✓ engineering
- ✓ transfer of technology

Aboriginal Joint Ventures: Negotiating Successful Partnerships, Mike Lewis and William Hatton, Centre for Community Enterprise, 1992.

This book is intended to assist First Nations which are considering the joint venture as a way to build an economic base for community self-reliance. Within that context, it details how to plan and negotiate joint ventures systematically and effectively. Relevant information includes:

- **the benefits of joint venturing;**
- **joint ventures as a community building strategy;**
- **a 5-stage process for joint venture negotiation;**
- **getting ready to negotiate: doing your homework;**
- **selecting ventures and partners;**
- **negotiating the heads of agreement; and**
- **issues related to joint venture management.**

The book *Aboriginal Joint Ventures: Negotiating Successful Partnerships* by Lewis and Hatton (1992) is also recommended for aboriginal groups considering joint venture partnerships (sidebar).

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[1] NF Minister of Fisheries and Aquaculture -- Feb 17, 2000

[2] Burke Consulting Inc. 2000. Strategic Plan – Newfoundland and Labrador Aquaculture. Prepared for Newfoundland Dept. of Fisheries and Aquaculture.

[3] Mitchell Planning Partners 1998 in Strategic Plan – Newfoundland and Labrador Aquaculture 2000.

[4] NFLD Dept. of Fisheries and Aquaculture: 2001 Seafood Industry Year in Review

[5] *http://www.economics.gov.nf.ca/E2002/triton.asp*

[6] pers comm. Island Seafarms Ltd. 2002

[7] £56 Million New Aquaculture Development Plan Launched. http://www.irishseafood.com/aqua_dev_plan.html

[8] Intrafish Chilean oyster farming initiative continues to garner interest 17.06.2002

[9] *Source Intrafish 20.11.2002*

[10] John Sackton 22-Nov-02 *http://www.seafood.com*

[11] Joaquin Cordua Espacios. Vol. 15 (1) 1994 *http://www.revistaespacios.com/a94v15n01/100941501.html*

[12] Joy, J. 1999. Joint ventures and aboriginal economic development: You can't even be like you once were yourself, let alone like somebody else. *http://www.wob.nf.ca/News/1999/Nov 99/joint_ventures1.htm*

11.0 Regional Strategy for Shellfish Aquaculture Development

Table of Contents

11.1 Introduction 2
11.2 SWOT Analysis: First Nation shellfish Aquaculture Development 3
SWOT Analysis Table: First Nation Shellfish Aquaculture Development 4
11.3 Species Specific Evaluation Frameworks 5
Evaluation Framework: Pacific Oysters 6
Evaluation Framework Blue and Mediterranean Mussels 7
Evaluation Framework: Japanese Scallops 8
Evaluation Framework: Manila Clams 9
Evaluation Framework: Northern Abalone 10
Evaluation Framework: Cockles 11
Evaluation Framework: Geoducks 12
Evaluation Framework: Green Sea Urchins 13
Evaluation Framework: Kelp Culture 14
11.4 Regional Strategy Overview 15
11.5 Regional Strategy Recommendations 17
Theme 1: Business Development and Management 17
Theme 2 Site Selection 25
Theme 3 Safety Assurance 27
Theme 4: Products, Processing and Markets 28

11.1 INTRODUCTION

The goal of this section is to summarize the information provided in the previous sections and present it in such a way as to provide guidance that will lead to informed decision making processes by both First Nations and Government stakeholders alike.

The goal is not to make decision for stakeholders but rather to provide recommendations that should be implemented in order to create a viable and sustainable shellfish aquaculture industry on the Central and North Coast.

As different First Nation groups are at varying levels within their planning and development processes, the information provided in this section of the regional strategy regional strategy is specific to the Central and North Coasts as a whole. It is recognized that some First Nations may not choose to develop shellfish aquaculture operations with their territories and that others may have their own development goals that supercede portions of these recommendations.

Recommendations on siting specific to individual First Nation territories are left in Section 5 in order to reflect the confidentiality of specific territory information.

The components of the regional strategy include:

- A SWOT analysis, which provides an overview framework or the Strength and Weaknesses of the current situation and the Opportunities and Threats that face the development of a viable shellfish aquaculture industry on the North Coast.
- An evaluation framework for the 9 shellfish species groups that are discussed in throughout the previous sections.
- A regional development strategy framework, which presents a series of concurrent actions, which must occur for the logical development of an industry. These action steps are presented in relative order.
- A summary of the major components of the regional development strategy framework and a series of individual recommendations appropriate to each component.

11.2 SWOT ANALYSIS: FIRST NATION SHELLFISH AQUACULTURE DEVELOPMENT

SWOT analysis is the process of carefully inspecting the business and its environment through the various dimensions of *Strengths, Weaknesses, Opportunities, and Threats.*

Strengths and *Weaknesses* are internal factors. *Opportunities* and *Threats* are external factors. Often carrying out a simple analysis using the *SWOT* framework will be enough to reveal changes that can be usefully made. As with most management analysis tools, *SWOT* in of itself will not give specific answers. Instead, it is a way to organize information and assign probabilities to potential events - both good and bad - as the basis for developing business strategy and operational plans.

A SWOT analysis table has been prepared on the following table that examines the issues surrounding the development of the shellfish aquaculture industry on the Central and North Coast. These factors are based on an assessment of the industry, market conditions and issues facing development.

Strengths ***are the company's core competencies, and include proprietary technology, skills, resources, market position, and others.***

Weaknesses ***are conditions within the company that can lead to poor performance, and can include obsolete equipment, no clear strategy, heavy debt burden, poor product or market image, weak management, and others.***

Opportunities ***are outside conditions or circumstances that the company could turn to its advantage, and could include a specialty niche skill or technology that suddenly realizes a growth in broad market interest.***

Threats ***are current or future conditions in the outside environment that may harm the company, and might include population shifts, changes in purchasing preferences, new technologies, changes in governmental or environmental regulations, or an increase in competition.***

SWOT Analysis Table: First Nation Shellfish Aquaculture Development

INTERNAL	
STRENGTHS	**WEAKNESSES**
• Large inventory of biophysically capable marine lands available for development • High water quality • Potentially less competing resource uses compared to South Coast • Significant government support for industry • Public enthusiasm for shellfish as a driver for sustainable economic development • Planning, production and marketing expertise available on South Coast • Many skill sets required for operations already possessed from Commercial fishing industry	• Long distance to major markets • Lack of experience, human resources capacity issues, training requirements • No established industry in region • Community acceptance and goals not well established in some communities • Lack of cooperation between individual First Nations • Individuals generally unwilling to consolidate efforts in grow-out processing and marketing • Availability of seed stocks /brood stocks • Culture not well established for many potential species • Lack of equity and tangible assets in tenures and stock limit financing ability • Production difficulties relating to Harmful Algal Blooms and severe weather
EXTERNAL	
OPPORTUNITIES	**THREATS**
• Strong demand for farmed shellfish products • Opportunities for integration of existing and new technologies • Underutilized processing facilities • High unemployment – available workforce • Strong marketing opportunities for regional branding. • Support for sustainable economic development • Development of value added processing is expanding sales and marketing opportunities	• User conflicts and regulatory restrictions on the industry • Competitive global marketplace increasingly competitive pricing • Difficulties in attracting capital investment • High costs and risk of developing value added processing. • Market penetration will require expensive and targeted marketing campaigns • Long period between investment and return for shellfish aquaculture

11.3 SPECIES SPECIFIC EVALUATION FRAMEWORKS

Evaluation frameworks are provided for each of the 9 species groups, which were considered in the preceding sections of the report (Pacific oysters, Japanese scallops, Mussels, Manila clams, Sea urchins, Geoducks, Northern Abalone, Cockles and Kelps.).

These overviews provide a decision-making framework by reviewing in general terms the following characteristics of culturing each species group within the Central and North Coast Region on a regional scale. In many cases what this framework does is identify where there are significant information gaps that must be addressed in order to make an educated decision as to which species to culture.

Biophysical Capability: the primary characteristics affecting determining site selection based on biophysical capability (as discussed in Section 4) for each species.

Production Potential – Biological: The primary factors affecting biological production (culture) potential for each species.

Production Potential – Economic: The primary factors affecting the economics of culturing each species in the region.

Marketing Potential: Factors regarding the marketability of primary or secondary products derived from culture of the species including general issues of pricing and market demand.

Processing/Transportation: Issues regarding the logistics and costs of processing and transportation of each species including processing requirements and relative weight versus product value.

Human Resource Capabilities: Relative scales of the human resources needs for the culture of each species.

Capital Requirements: Relative information of the scale of capital required to develop culture systems for each species.

In each case a positive (+), negative (-) or neutral (+/-) determination is provided for each aspect discussed. Ranking or weighting of these variables is not provided as in many instances missing information is only identified and different proponents may interpret rankings differently depending on their situations.

Information from these evaluations is used to make species specific recommendations later in the section.

Evaluation Framework: Pacific Oysters

Evaluation Factors	Discussion	+/-
Biophysical Capability	Colder waters in some areas of North Coast may significantly affect growth rates	(-)
Production Potential – Biological	Established culture methods and equipment Hardy species can handle a wide range of temperatures and salinity Established seed sources in BC and US Few, if any, significant disease problems in BC	(+) (+) (+) (+)
Production Potential - Economic	Performance, cost and market data are required to determine potential viability	(-)
Marketing Potential	Strong potential for value added processing Strong export market potential Product is a commodity and prices are competitive Half shell markets require year round and regular service	(+) (+) (-) (-)
Processing/Transportation	Fresh product is bulky and low value for weight Requires a comprehensive transportation cost reduction strategy to enhance competitiveness	(-) (-)
Human Resource Capabilities	Labour intensive but may be partially mechanized Lack of knowledgeable personnel; extensive training and tech transfer required Skills transfer available from South Coast	(+) (-) (+)
Capital Requirements	External private/public investment needed to reach economies of scale Investment prospecting required to attract new investment for joint venture	(-) (-)

Evaluation Framework Blue and Mediterranean Mussels

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Blue mussels are hardy species and suitable for cold water; can handle wide range of temperature and salinity	(+)
	Mediterranean mussels require warmer water and subject to high mortality. Requires testing in local environment	(-)
Production Potential – Biological	Established culture methods and equipment, mussel culture is easily mechanized	(+)
	Seed supply is not well established, and may require local hatchery development	(-)
	Bird predation and avoidance techniques significant factor	(-)
Production Potential - Economic	Performance, cost and market data are required to determine potential viability	(-)
Marketing Potential	The North American market for fresh and secondary mussel products has experienced strong growth and this growth is expected to continue	(+)
	Fresh mussels are a commodity and prices are competitive	(-)
Processing/Transportation	Strong potential for value added processing techniques	(+)
	Fresh product is bulky and low value for weight	(-)
	Value added processing has the potential to remove the competitive disadvantage with respect to transportation and shelf life.	(+)
	Requires a comprehensive transportation cost reduction strategy to enhance competitiveness	(-)
Human Resource Capabilities	Labour intensive but may be partially mechanized	(+)
	Lack of knowledgeable personnel; extensive training and tech transfer required	(-)
	Skills transfer available from south coast	(+)
Capital Requirements	External private/public investment needed to reach economies of scale	(-)
	Investment prospecting required to attract new investment for joint venture	(-)

Evaluation Framework: Japanese Scallops

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Well suited to cold oceanic water of Central and North Coast	(+)
Production Potential – Biological	While culture methods are established, no track record in BC - a commercial scallop sector has not evolved Site selection critical; requires specific temperature, exposure and salinity regimes Scallops are fastidious and may suffer high mortality if conditions are not correct Hatchery seed only and at present only one established source of seed in BC, constraining new development Disease problems have been encountered at some sites (reasons unknown) Affected by bio-fouling	(-) (-) (-) (-) (-) (-)
Production Potential - Economic	Performance, cost and market data are required to determine potential viability	(-)
Marketing Potential	High value product, demand in marketplace high Prices are at high levels Scallops require a long time to depurate PSP (can be >6 mos). Affects potential for whole market sales	(+) (-)
Processing/Transportation	High value per weight for whole and fresh scallops Fresh whole scallops have short shelf-life	(+) (-)
Human Resource Capabilities	Scallop farming still fairly labour intensive. Lack of knowledgeable personnel; extensive training and tech transfer required	(-) (-)
Capital Requirements	External private/public investment needed to reach economies of scale Investment prospecting required to attract new investment for joint venture	(-) (-)

Evaluation Framework: Manila Clams

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Requires specific types of beaches for culture High capability with appropriate beaches and oceanographic conditions Much of Central and North Coast is too cold for natural spawning or recruitment	(-) (+) (-)
Production Potential – Biological	Established culture methods with little mechanization required Technology (netting) readily available Hatchery seed readily available Wild populations not established in Central/North Coast/Haida Gwaii, cultured populations not tested Subject to winter kill from freezing temperatures	(+) (+) (+) (-)(-)
Production Potential - Economic	Performance, cost and market data are required to determine potential viability	(-)
Marketing Potential	Strong Market for fresh product Clams are a commodity and prices are competitive	(+) (-)
Processing/Transportation	Fresh product has high value for weight Requires a comprehensive transportation cost reduction strategy to enhance competitiveness	(+) (-)
Human Resource Capabilities	Labour intensive harvesting Lower levels personnel knowledge, training and tech transfer required	(-) (+)
Capital Requirements	External private/public investment needed to reach economies of scale Low level of capital required compared to other species	(-) (+)

Evaluation Framework: Northern Abalone

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Suitable for culture in Central and North Coast, due to indigenous factor Requires very high water quality	(+) (-)
Production Potential – Biological	Culture methods not established in BC Technology transfer available internationally Significant disease issues encountered in other previous projects Capability of using artificial feeds Natural feeds may require kelp farming operations Not affected by marine biotoxins in BC	(-) (+) (-) (+) (-) (+)
Production Potential – Economic	Most culture systems are on-land and capital expensive Significant regulatory issues including broodstock access Economic potential not proven in BC Very slow to market size On-land systems require access to power Not subject to CSSP program regulations	(-) (-) (-) (-) (-) (+)
Marketing Potential	Very High value product -strong market demand	(+)
Processing/Transportation	Fresh product has highest value for weight	(+)
Human Resource Capabilities	Very high levels personnel knowledge, training and tech transfer required	(-)
Capital Requirements	External private/public investment needed to develop capital intensive systems High level of capital required compared to other species	(-) (-)

Evaluation Framework: Cockles

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Suitable for culture in Central and North Coast, due to indigenous factor Large numbers of high biophysical capability beaches	(+) (-)
Production Potential – Biological	Indigenous to BC While R&D investigations suggest culture potential, efficient culture techniques not yet established Seed production still experimental	(-) (+/-) (-)
Production Potential – Economic	Production economics not known Potential regulatory issues associated with indigenous species cultivation (broodstock etc)	(-) (-)
Marketing Potential	Low market demand, requires marketing program Important First Nations traditional food source Market value not known	(-) (+) (-)
Processing/Transportation	Unknown	(+/-)
Human Resource Capabilities	Low levels personnel knowledge, training and tech transfer required for grow-out	(+) (-)
Capital Requirements	Low level of capital required compared to other species	(+)

Evaluation Framework: Geoducks

Evaluation Factors	Discussion	+/-
Biophysical Capability	Suitable for culture in Central and North Coast, due to indigenous factor Requires specific intertidal or subtidal habitats	(+) (-)
Production Potential – Biological	Culture methods still being developed Significant predation issues may arise from increasing sea otter populations	(-) (-)
Production Potential – Economic	Significant regulatory issues with DFO affect culture ability Economic potential not proven Very slow to market size Subtidal farming operations very expensive due to WCB diver requirements	(-) (-) (-) (-)
Marketing Potential	Very High value product -strong market demand Potential market correction with increased volumes	(+) (-)
Processing/Transportation	Fresh product has high value for weight	(+)
Human Resource Capabilities	Very high levels personnel knowledge, training and tech transfer required	(-)
Capital Requirements	External private/public investment needed to develop capital intensive seed rearing systems	(-)

Evaluation Framework: Green Sea Urchins

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Suitable for culture in Central and North Coast, due to indigenous factor	(+)
Production Potential – Biological	Indigenous to BC Potential for reseeding or culture based fishery While R&D investigations suggest culture potential, efficient culture techniques not yet established Seed availability not established Significant potential for Roe enhancement	(+) (+) (-) (-) (+)
Production Potential - Economic	Profitability unknown or not proven Potential for short term value adding of fisheries products Capital intensive on-land facilities maybe required Not subject to CSSP program regulations	(-) (+) (-) (+)
Marketing Potential	Strong market potential	(+)
Processing/Transportation	Unknown	(+/-)
Human Resource Capabilities	Lack of knowledgeable personnel; extensive training and tech transfer required Limited expertise in existing BC shellfish aquaculture sector	(-) (-)
Capital Requirements	Potentially higher cost requirements; few, if any role models to learn from External private/public investment needed to reach economies of scale Investment will be difficult to attract as business models are not established	(-) (-) (-)

Evaluation Framework: Kelp Culture

Evaluation Factors	**Discussion**	+/-
Biophysical Capability	Indigenous to BC, common through-out Central and North Coat with abundance of capable sites North Coast site selection requirements not well defined.	(+) (-)
Production Potential – Biological	Indigenous to BC Fast Growth rate (annual crops) Culture methods well established Seed availability– little commercial production at this time	(+) (+) (+) (-)
Production Potential – Economic	Profitability unknown or not proven Not subject to CSSP program requirements	(-) (+)
Marketing Potential	Market potential not well explored – Low commercial demand Highest immediate potential is stabilizing supply to lucrative Roe on Kelp industry May be required to support abalone or urchin culture	(-) (+) (+)
Processing/Transportation	High biomass relative to low prices ($ per tonne)	(-)
Human Resource Capabilities	Lack of knowledgeable personnel, tech transfer required Most grow-out techniques are straightforward	(-) (+)
Capital Requirements	Most types of grow-out operations require relatively low amounts of capital and infrastructure Investment will be difficult to attract as business models are not established	(+) (-)

11.4 REGIONAL STRATEGY OVERVIEW

A regional development strategy framework is diagrammed in the following figure. This framework presents a series of concurrent actions, which must occur for the logical development of a viable and sustainable shellfish aquaculture industry on the Central and Northern Coast of BC.

This strategy framework is independent of the species cultured and does not identify specific timelines but instead the relative order in which events must occur. In should also be noted that many of the specific tasks within each theme are interrelated with tasks in other themes and thus, the process should be viewed as a whole.

This framework is divided into 4 themes and each is of equal importance for industry development. These themes are:

1. Business Development and Management

   This includes the flow of development from regional coordination , through strategic planning, development of management teams, business planning etc. through to commencement of commercial aspects. This theme is largely restricted to the business and management aspects of the business aspects of shellfish aquaculture

2. Site Selection

   This includes the flow of tasks from site capability investigations to pilot testing and the steps necessary to obtain tenures and in the initiation of physical operations on selected tenured sites.

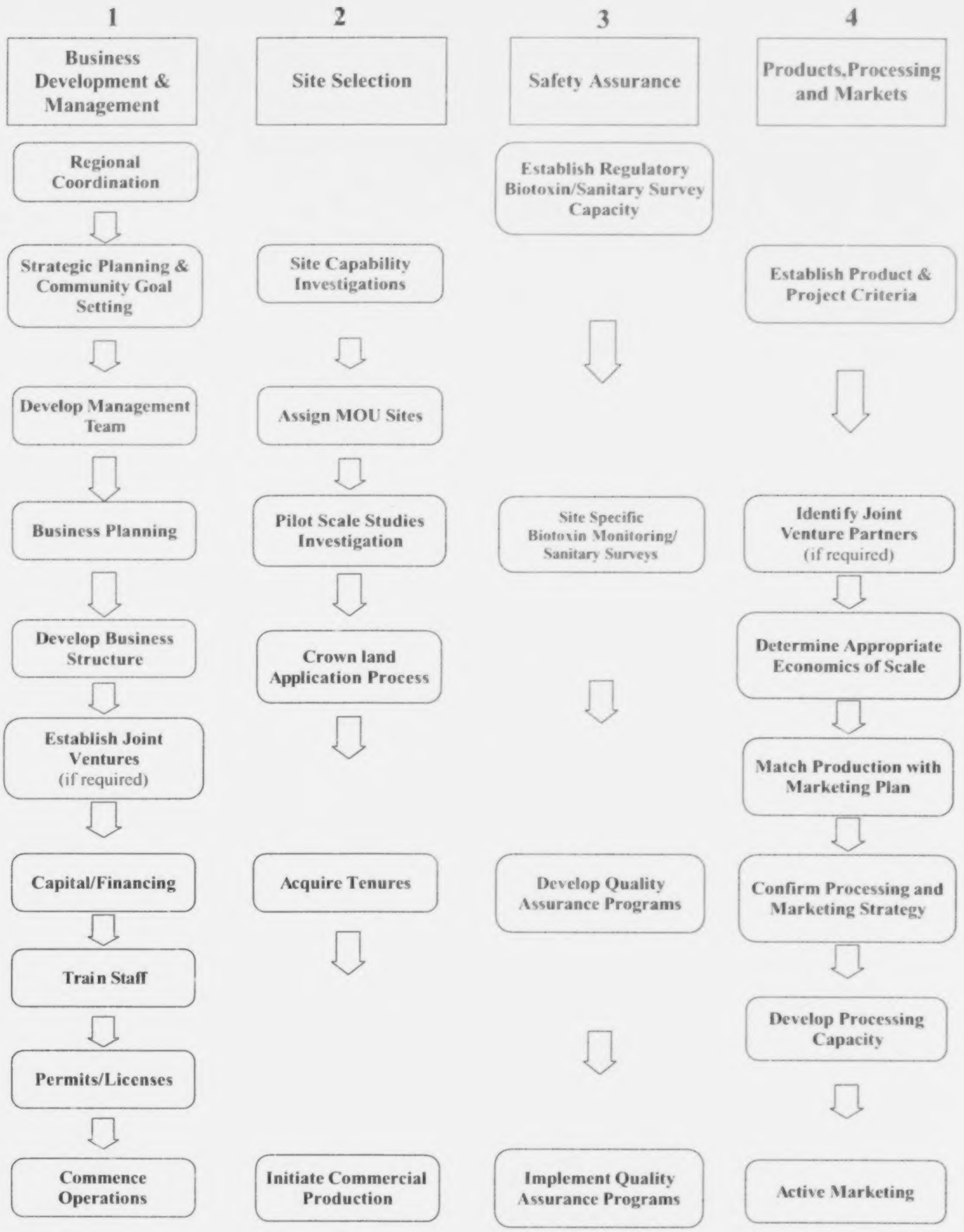
3. Safety Assurance

   This includes the development of critical local capacity for biotoxin and sanitary survey programs in the region, through to the development of quality assurance programs on commercial tenures necessary for marketing and competitiveness once operations begin to produce crops.

4. Products, Processing and Markets

   This includes the strategic decision making processes on what products will be farmed, the development of economies of scale, matching this with marketing plans and strategies, developing processing capacity and finally, actively marketing products once crops come on-line.

Figure 11.1 Schematic and Relative Order of Tasks for a Regional Development Strategy Organized by Themes


1
Business Development & Management
Regional Coordination
Strategic Planning & Community Goal Setting
Develop Management Team
Business Planning
Develop Business Structure
Establish Joint Ventures (if required)
Capital/Financing
Train Staff
Permits/Licenses
Commence Operations
2
Site Selection
Site Capability Investigations
Assign MOU Sites
Pilot Scale Studies Investigation
Crown land Application Process
Acquire Tenures
Initiate Commercial Production
3
Safety Assurance
Establish Regulatory Biotoxin/Sanitary Survey Capacity
Site Specific Biotoxin Monitoring/ Sanitary Surveys
Develop Quality Assurance Programs
Implement Quality Assurance Programs
4
Products,Processing and Markets
Establish Product & Project Criteria
Identify Joint Venture Partners (if required)
Determine Appropriate Economics of Scale
Match Production with Marketing Plan
Confirm Processing and Marketing Strategy
Develop Processing Capacity
Active Marketing

11.5 REGIONAL STRATEGY RECOMMENDATIONS

Theme 1: Business Development and Management

Regional Coordination

To achieve the objectives of a regional strategy, implement the recommendations of this document and expedite the involvement of First Nations communities in business ventures, it will be important to establish small steering committees in both the Central and North Coasts.

The interest for shellfish aquaculture development must come from the communities themselves. Once initiated, interest has to be maintained from within the communities, mainly by one or more advocates or 'champions' who continue to drive development projects.

There is a very strong need to participate with others in the BC shellfish aquaculture industry (i.e. BCSGA), so North Coast growers have an awareness of programs and initiatives underway. For example, national shellfish initiatives such as On Farm Food Safety and National Codes of Practice will have a direct impact on any shellfish aquaculture business and on future marketing initiatives.

Recommendation #1. Steering Committees

Establish a Steering Committee(s) in both the Central and North Coast to encourage First Nations involvement in shellfish aquaculture and assist in implementing the recommendations in this strategy.

Recommendation #2. Regional Coordination

Coordination should be established along First Nation territory divisions of where product will be landed for example: Kitasoo South to Port Hardy and Hartley Bay North (Tsimshian, Haida and Haisla Nations with Prince Rupert as main staging area.

Recommendation #3. Coordinators

Consideration should be given to the hiring of a Coordinator for each Steering Committee, who would assist the Committee in achieving its goals. In the North Coast, examine expanding the role of the North Coast Water Quality Biotoxin Society to serve in this capacity.

Recommendation #4. **Community Champions**

In each of the regions within the Central and North Coast, identify people who could act as 'champions' to build knowledge and awareness within the communities interested in shellfish aquaculture development.

Project Planning & Environmental Sustainability

At a community level, it is essential for stakeholders and other community members to be fully aware of what is involved in shellfish aquaculture. They must have a realistic expectation of the rewards and returns as well as the long-term commitment in time and effort needed to achieve successful outcomes.

First Nations groups need to be fully involved in the planning process from its inception. The planning process needs to take into account issues such as the level of participation in the project, training, employment opportunities as well as confirming processing capacity and markets for the end product. Development corporations or project management teams must understand that sustainability and economic success are equally important and not mutually exclusive goals.

To ensure success, the following social, cultural and environmental issues must be considered before initiating on any shellfish aquaculture venture:

- ☐ Projects should not adversely impact on environments on which communities are socially or culturally dependent
- ☐ The overall regional strategy needs to be sufficiently flexible to accommodate the individuality and the differences between communities. Adequate consultation with communities is essential
- ☐ Proposed projects should be compatible with the cultural practices of communities.
- ☐ Conflict arising from differences within and between communities needs to be overcome.

Recommendation #5. **Strategic Planning**

Prior to the commencement of any shellfish aquaculture venture, strategic planning must include consideration of the various business structures, training needs, employment opportunities,

processing capacity, marketing opportunities as well as social and cultural issues.

Recommendation #6. Environmental sustainability

During the planning process, ensure sensitive areas will not be disturbed and emphasis is placed on environmental management and sustainability.

Joint Ventures

Where possible, projects should involve companies that have marketing expertise and control market access (distributors, processors, wholesalers) from the beginning, either through joint venture or some other relationship.

For example, consideration should be given to forming partnerships with brokers and other trading companies. This will provide better access to foreign markets that these large companies are already associated with.

The development of strategic alliances amongst growers and processors is strongly recommended to enable the development of regular harvesting plans and thereby ensure continuity of supply.

Recommendation #7. Strategic Alliances

The final strategy should be to work towards developing partnerships and strategic alliances, in an effort to become as vertically integrated as possible: seed production through to final marketing.

Recommendation #8. Strategic Alliances

Encourage and support the formation of strategic alliances in the areas of:

- ☐ ***Financing***
- ☐ ***Group purchasing***
- ☐ ***Grow-out, processing and marketing***

Economies of Scale

Increasing economies of scale for farmers and processors through production growth and improved collaboration, was one of the key lessons from the Newfoundland Case Study outlined in Section 10.

Recommendation #9. Corporate Projects

Major projects should be developed by corporate entities, which can provide infrastructure support to smaller and potentially more diverse aquaculture projects established by individuals.

Recommendation #10. Cooperatives

Cooperatives, which are based on First Nations held sites with individual ownership of culture units (rafts etc.) or sub-areas of larger tenures, should be investigated

Recommendation #11. 'Piggy Back' Infrastrucutre

When possible, projects should 'piggy-back' on infrastructure being developed by other initiatives. Most noticeably is finfish aquaculture in the region.

Compatibility with Other Industries

Development in shellfish aquaculture and compatible industries such as recreation and tourism are possibly interdependent and may in fact be mutually beneficial. The eco-tourism industry is experiencing rapid growth and may provide an excellent opportunity for First Nations projects to capitalize on additional revenue generated from tourism. It is recommended that the option of integrating First Nations shellfish aquaculture development planning within the larger context of planning for the overall economic development of communities and regions be explored.

Recommendation #12. Integration with other industries

Explore options of integrating First Nations shellfish aquaculture development planning within the larger community economic development planning process (i.e. eco-tourism)

Linkages with Non-aboriginal Projects

Due to the infancy of the industry on the Central and North Coast and the wide array of infrastructure, political and market issues facing the industry, a strong level of technical support and expertise will be needed in the developmental process. As a result, strategies must not be restricted to any one First Nations group and should include and support non-aboriginal projects, unless dictated by a specific project or geographic constraint.

Recommendation #13. Support non-aboriginal projects

Explore options to include and support non-aboriginal shellfish aquaculture projects along with First Nations projects.

Develop Project Management Team

A key challenge for First Nation communities is the development of capacity to participate equally with partners such as large corporations. In some cases, this may be related to the lack of community management level expertise.

For successful development of project teams that can move shellfish aquaculture forward in the community, there is also a clear need to separate business from politics. Business is often affected by local politics. For example, some band council members are voted in every few years. Changing leadership agendas in the short term can negatively affect business operations and relationships over the long term.

Recommendation #14. Political Processes

Development corporations or project management teams should be removed as much as possible from internal political drivers and processes. A solution may be to develop a written agreement or contract between the band council and community at large not to allow changing leaderships to affect long-term shellfish business operations.

Recommendation #15. Boards of Directors

Development corporations or project management teams should establish Boards of Directors to provide corporate guidance.

Recommendation #16. External Expertise

At the outset, senior management or Boards of Directors should bring on those with specific culture expertise as well as business experience and leadership into management teams, with the goal of developing local capacity over time through hands on development. Building capacity at the local level will assist First Nation communities to participate equally in partnerships.

Business Planning

The lack of understanding of basic business principles – especially management level expertise - among community members is a major obstacle in developing business partnerships.

The importance of a written business plan cannot be under emphasized; it exposes thoughts, assumptions and research findings to reason. The business plan takes the perceived goals of a project and explores whether the plan will work and what resources will be needed to initiate the plan and carry it through in the future. Private and institutional investors require business plans so that they know what they are investing in, how their money will be used and what returns they can expect.

Recommendation #17. Business Planning

Ensure all shellfish aquaculture business plans explain the business concept, summarize the objective of the business, identify the resources (money and people) that will be needed by the business, describe how those resources will be obtained, and inform the reader why the business will succeed.

Recommendation #18. Business Planning Training

Encourage First Nation participation in information workshops and conferences to familiarize community members with a basic understanding of business principles.

Business Structure

A major challenge for the development of First Nation shellfish aquaculture will be to develop an appropriate business model that allows for the negotiation of successful joint ventures without the complication of band politics. Conventional business models usually stress the amount of capital investment put into the business venture by each partner. Alternative models, such as cooperatives, need to be explored.

Recommendation #19. Business Structures

Prior to engaging in any sort of shellfish aquaculture business development, First Nations groups should establish basic business goals and employ legal advice in determining what sort of formal business structure will best suit their needs.

Establish Joint Ventures & Capital Investment

Joint ventures with groups from outside First Nations territories may be a critical way to bring investment, management, and technology transfer to economically viable aquaculture development projects. For example, cooperative agreements on marketing could reduce transportation costs, promotional expenses and potentially create a pooling of product volumes necessary for effective and sustained market penetration.

For successful industry development, it is vital that adequate investment capital be encouraged. Investor confidence will improve through effective industry management, coordination, profitability and sustainable production.

Recommendation #20. Joint Ventures

Strongly encourage joint venture partnerships that bring a combination of financial investment, technical, business and marketing management skills to any proposed shellfish aquaculture project.

Recommendation #21. Investment strategies

A targeted investment-prospecting program should be initiated to match First Nations groups with willing investors and joint venture partners.

Education and Training

In order to develop a successful shellfish aquaculture development project(s) strong emphasis must be placed on human resources from the outset. To achieve significant production and a profitable industry, a high priority should be placed on developing both business management and technical expertise relevant to shellfish aquaculture. In addition to training in the area of production methods and techniques and business, training in the area of marketing also remains important.

Recommendation #22. Business Training

Encourage coordination of business management training to develop skills in areas including inventory management, cash flow management business planning, sales and marketing management.

Recommendation #23. Training

Develop links with Malaspina University College - Centre for Shellfish Research (MUC-CSR), as they are developing accredited training initiatives focused on the needs of First Nations entering the industry. Once developed, courses and program will be transferable to local training delivery agents (e.g. community colleges).

Recommendation #24. Training Networks

To increase community awareness of available training, information networks should be established between communities. For example, developing websites, distributing resource lists and holding information workshops should be considered.

Permits and Licenses

As summarized in Section 8, there is a complex array of necessary municipal, provincial and federal licenses, permits and registration requirements prior to the start up of any shellfish aquaculture business. It will be very important that prospective aquaculturists realize the implications of the various regulations and understand how they impact developing aquaculture operations. As a result, someone from the Regional Committees (e.g. Coordinator) needs to work with government, as well as provincial and national industry associations, to understand these regulations and comply with the necessary requirements to enable production to commence in a timely manner.

Recommendation #25. Permitting and licensing

Ensure all shellfish aquaculture projects comply with the necessary license conditions, provincial and federal regulations as well as environmental codes of practice outlined in this report.

Recommendation #26. Licensing Coordination

The role of the Steering Committee Coordinator should include coordination and assistance of the licensing process to facilitate more timely approvals.

Theme 2 Site Selection

Site selection is the first and generally the most critical step in establishing a sustainable aquaculture facility. The success of an aquaculture enterprise is dependent on the selection of a suitable site, as poor site selection can lead to failure. For the long-term sustainability of an aquaculture enterprise, it is good investment sense to select an environmentally sound, low risk site at the outset.

Poor siting and location has been a significant factor in the failure of aquaculture in some areas, and excessive environmental impacts in others. Prior to conducting any technical or economic assessment of shellfish aquaculture in the coastal zone, site selection criteria should take precedence.

Experience has shown that unless the sites are biologically and physically capable of supporting the chosen type of shellfish culture, operations will be limited by these aspects for the duration of the culture activities and the culturists will spend their careers compensating for the limitations of their site.

It is highly recommended that shellfish culturists only use the results of the BCMAFF Shellfish Culture Capability appraisals **as a guide to site selection**. Further follow-up trials should employ seasonal sampling, detailed inspections and trial grow-out studies.

In addition to being biophysically capable of supporting aquaculture operations, sites must make good economic sense. Consequently a number of factors affect site suitability.

Sites should be of a minimum size to provide the necessary amount of growing area that will support enough production to justify the economies of scale required for economic success. This should also take into account future potential growth of the operation. Access to multiple sites within a company's area of operations may be an alternative to the size of individual sites. As an estimate, the BC Shellfish Growers Association has stated that 10 hectares is a sufficient minimum for deep water operations.

A way to make the shellfish aquaculture industry more competitive is to create clusters of tenures. By clustering farms and pre-approving multi-site applications, the industry can collectively share the cost of support services, combine product volumes to meet market demand and organize transportation efficiencies.

Recommendation #27. **MOU Sites**

While initial MOU sites need to be established with First Nations territories, these should not necessarily be viewed as the final shellfish aquaculture site that may be potentially developed in the future.

Recommendation #28. **Multi-site applications**

Encourage the submission of multi-site applications, pre-approved by the local Steering Committee and Coordinator.

Recommendation #29. **Site investigations**

Depending on status and interest of individual communities, additional research (i.e. individual site capability and community knowledge/acceptance) may be necessary before any proposed shellfish aquaculture project is initiated.

Recommendation #30. **Deepwater sites**

When possible, deepwater sites should be chosen with a minimum 10-hectare area. Large 50 – 100+ hectare areas should be zoned or designated in advance, which would allow for future, multiple farm development within aquaculture zones.

Recommendation #31. **Tenure clustering**

Encourage clustering of tenures in areas with high biophysical capability with targeted production based on secured markets.

Recommendation #32. **Intertidal sites**

If possible, intertidal sites should be established where existing manila clam resources exist (South Central Coast or where there is potential for future Cockle enhancement or development in the Central and North Coast).

Pilot/Demonstration Projects

The basic understanding of commercial aspects of many culture types is not well established in many First Nations communities. Demonstration projects are necessary to build community acceptance and understanding. Demonstration farms would comprise small-scale commercial production units that apply and demonstrate technology as well as provide employment and training opportunities. Demonstration farms could play a critical role in development, by providing resources and facilities that show First Nations growout procedures that can be adopted and modified for use in various areas.

Recommendation #33. Demonstration Farms

When appropriate, demonstration farms could be established in selected communities.

Theme 3 Safety Assurance

Biotoxin/Sanitary Survey Capacity

Given that shellfish are often consumed whole, either raw or partially cooked, the water quality of shellfish growing areas has a direct impact on the potential health to consumers. Understanding and complying with issues, regulations, and monitoring programs relating to product safety is critical to the development and success of a shellfish aquaculture industry.

Bivalve shellfish are largely indiscriminate, immobile filter-feeders, and tend to reflect the chemical and biological quality of the growing water in which they live. Therefore, it is very important that Canadian shellfish come from monitored and approved water sources.

In most other regions of Canada, the federal government conducts water and biotoxin quality testing regularly. However, such testing has been very sporadic on the North Coast in recent decades due to a combination of factors, such as the remote nature of the area and the high costs involved in monitoring and testing. Consequently, one-third of BC's coastline has remained permanently closed for most shellfish activity for almost 40 years. This closure has impacted both recreational harvesting and First Nation traditional harvesting, and it has precluded the development of a shellfish farming industry on the North Coast.

Recommendation #34. Regulatory Monitoring

Continue to place emphasis on supporting, maintaining and increasing critical biotoxin monitoring and sanitary survey programs in the Central and North Coast.

Quality Assurance

Ensuring consistency of product quality is a key factor in successful marketing. Given that there may be a number of farms and management styles in operation, high quality standards will need to be considered to ensure brand differentiation and product claims are repeatedly attainable.

Recommendation #35. Quality Assurance

Ensure farm and plant workers are trained on appropriate quality assurance practices and that project planning incorporates necessary quality assurance programs.

Theme 4: Products, Processing and Markets

Prior to committing to markets that require year round product supply, it will be very important to ensure that contingency plans are in place to address possible seasonal closures due to biotoxin events and possible conflicts with traditional or commercial fisheries that require seasonal involvement of labour force.

Initial species should have the following attributes:

- ✓ Established culture techniques
- ✓ Ability to mechanize harvest and handling as much as possible
- ✓ Concentrate on Deep water culture techniques
- ✓ Established markets and opportunity for frozen and value added

The following key issues need to be taken into consideration when establishing species to culture:

- ☐ Mussel culture business plans must be weighed against potential cost of producing hatchery-produced seed.
- ☐ Oyster plans should avoid competitive traditional 'fresh' markets in South Coast with exception of small fresh volumes for local sales and North Coast corridor to Edmonton.
- ☐ Scallop projects should be prepared to on-grow adductor meat products (18-24 months) as smaller 'steamer' scallop products may be heavily impacted by retention of algal biotoxins.

When possible, major projects should target final products that can be frozen or value added, rather than fresh products. Benefits of this approach will include:

- ☐ Ability to harvest product when in season, when there is highest meat quality or when most efficient, from labour and transport perspective. After harvest, there is the ability to process and store inventory for year round sales.

- ☐ Avoidance of shutdowns related to marine biotoxin blooms or severe northern weather
- ☐ Logistics. It's cheaper, easier and safer to ship seafood products frozen than fresh. Shipping frozen will result in cheaper freight charges through utilizing whole trucks or sea going containers.

Recommendation #36. Economies of scale

Ensure a level of production is achieved in a given area to support the necessary infrastructure for processing, transport, harvesting equipment, seed production facilities (if required) and necessary monitoring programs.

Recommendation #37. Value added products

Major projects should target final products that can be frozen or value added rather than fresh products.

Recommendation #38. Component Development

Production should be developed on a component basis when possible to reduce risk, ie: if seed is available from outside sources, then first focus attention on developing grow-out techniques and expertise before developing seed production

Recommendation #39. Priority Species (growth)

Priority should be given to the development of species that have a short growth cycle time, preferably less than 24 months.

Recommendation #40. Priority Species (markets)

Biophysical requirements for culture capability for most species can be found within First Nation areas. Market choices more than capability should determine final choice of culture species.

Recommendation #41. Priority Species

Larger scale commercial culture should concentrate on developing cold-water species such as mussels, oysters and scallops (in order of priority).

Manila Clam Culture

Manila clams, which are now native to most of BC, are found as far north as the Bella Bella region with decreasing recruitment in waterways further north. In addition Manila clams have not recruited to beaches within Queen Charlotte Strait presumably because of cool water temperatures. It is unknown how far north the distribution of Manila clams will extend and concerns exist that planted Manila clams may be subject to winter freezing in the intertidal in northern regions. This cannot however be accurately predicted in the scope of the current investigation. Most of the current culture industry relies, to a certain extent, on naturally recruited Manila clams of which survival is increased through good husbandry practices. While planted clams may survive and grow, it is questionable whether they will reproduce and recruit back to culture beds in the study area.

A cautious approach should be taken to Manila clam culture in areas where the species has not already established itself. Prior to any development of Manila clam culture in the region, careful studies should be undertaken to further determine the success of Manila clam culture at a given site. Until such studies have been undertaken commercial Manila clam culture should be restricted to areas that have demonstrated regular recruitment and good growth and survival.

Recommendation #42. Priority Species (Manila clams)

Culture should be pursued in Southern Central Coast areas where capable grounds and existing recruitment exist.

Higher Value/ Higher Risk Native Species

The development of commercial culture for indigenous shellfish species holds much potential, however many barriers still exist including basic husbandry techniques, markets, broodstock and seedstock issues, diseases, feed sources and regulatory issues. First Nation's should balance the desire to develop these species into commercial culture with the high risk that may exist.

Recommendation #43. New Species development

Projects should support on a lower priority research and commercialization of native species: green sea urchins, abalone, cockles, geoduck, rock scallops and kelps.

Recommendation #44. New Species development

Whenever possible external funds should be used to further establish and demonstrate economic viability or establish appropriate technologies prior to initiating commercial culture projects for unproven native species.

Recommendation #45. New Species development

Culture technologies should focus on importing existing technologies rather than developing technologies from scratch for unproven native species.

- ☐ ***Sea Urchin*** *culture should focus first on developing roe enhancement projects rather than full cycle culture. Further R&D should be focused on addressing outstanding issues with respect to feed development and economic potential.*
- ☐ ***Abalone*** *culture should focus on demonstrating economic viability, husbandry challenges and disease issues as well as DFO regulatory constraints.*
- ☐ ***Urchin*** *and* ***abalone*** *culture projects should be associated with* **kelp culture** *projects for feed or supplemental feeds.*
- ☐ ***Cockle*** *culture should focus on basic seed development, siting and husbandry investigations.*
- ☐ ***Geoduck*** *projects should focus on determining biophysical capability and economic viability.*
- ☐ ***Rock scallop*** *culture should focus on husbandry and economic viability.*
- ☐ ***Kelp*** *culture for use in Roe on Kelp should be pursued by establishing feasibility and market.*

Recommendation #46. Broodstock and Seedstock

Work to resolve broodstock and seedstock issue with Transplant committee to gain unencumbered access to native broodstocks and to commercial seedstock sources.

Develop Processing Capacity

Bivalve shellfish may only be sold to, or processed in, a federally and provincially certified and registered facility. Those registered facilities are in good standing with the Canadian Food Inspection Agency (CFIA) and meet all of the requirements of the Fish Inspection Regulations. This includes the requirements to have an acceptable Quality Management Program in operation. For new operations in the North Coast this will necessitate the specific licensing of processing facilities to include bivalve shellfish, which will add significant costs to any new venture. Sufficient orders of scale of production must be achieved in order to support the construction, licensing and overhead costs of processing facilities.

From initial research, it would seem that there are some underutilized processing facilities, cold storage and other infrastructure in the Central and North Coast area. Whenever possible, piggy backing on existing infrastructure capacity allows for streamlining of costs and reduction of regulatory requirements and barriers.

Recommendation #47. Processing facilities

Any new venture must anticipate and develop processing requirements and licensing into business plans.

Recommendation #48. Underutilized facilities

To achieve cost and time efficiencies, focus efforts on developing existing or underutilized facilities and infrastructure with the area.

Match Production with Marketing

Well-integrated production and marketing plans are an essential part of shellfish aquaculture project planning. While potential new markets are outlined in this report (Section 7), additional research will be needed, to verify the best opportunities for establishing specific distribution channels and sales networks.

As part of this planning process, consideration of pricing will be needed. All North Coast shellfish aquaculture operations growing products for distant markets will need to command a premium price in the marketplace to offset the disadvantage of distance.

Recommendation #49. Match production with market

Before growing any shellfish species, a confirmed marketing plan that matches the production plan must be developed. The plan needs to outline where the product will be processed and which markets are being targeted.

Recommendation #50. Market Intelligence

Industry needs to be advised of sources of market intelligence information on product demand, product availability and pricing. This role may be undertaken by Regional Coordinators.

Regional Branding

Regional branding and identification will be key in positioning product in the marketplace. There are definitely market opportunities for the right mixes of marketing approach, campaign and product line. Without development of an identifiable brand, the product becomes just another oyster (or mussel or scallop), subject to all the price constraints that come with traditional commodity markets.

Invest in identification and communication of the product and build an identifiable First Nations Northern BC image that communicates the positive attributes of:

- ☐ pristine water quality and environmental sensitivity
- ☐ product quality and safety
- ☐ First Nations long standing sense of 'heritage' with shellfish

However, further research will be needed to identify exactly what the North Coast brand should be.

Recommendation #51. Market branding

Through market research, develop a regional brand that capitalizes on geographic and quality features and incorporates marketing effort into vertical integration.

Market & Product Development

Market and product development need to become a priority in order to secure new markets and pursue appropriate value added products.

Recommendation #52. Market Development

Market intelligence and opportunities in fresh and value added products must be pursued for the North American market.